

**REQUEST FOR INCIDENTAL HARASSMENT
AUTHORIZATION FOR THE INCIDENTAL HARASSMENT OF
MARINE MAMMALS RESULTING FROM THE USE OF HULL
MOUNTED MID-FREQUENCY ACTIVE TACTICAL SONAR IN
ASW TRAINING EVENTS CONDUCTED DURING THE RIM OF
THE PACIFIC (RIMPAC) EXERCISE**

HAWAIIAN ISLANDS OPERATING AREA

Submitted to:

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ADC	Acoustic Device Countermeasures
ASW	Antisubmarine Warfare
CASS/GRAB	Comprehensive Acoustic System Simulation Gaussian Ray Bundle
CFR	Code of Federal Regulations
CV	Coefficient of Variation
dB	Decibel
DoN	Department of the Navy
EEZ	Exclusive Economic Zone
EL	Energy Flux Density Level
ESA	Endangered Species Act
GDEM 3	Generalized Digital Environmental Model
GRAB	Gaussian Ray Bundle
IHA	Incidental Harassment Authorization
IUCN	World Conservation Union
IWC	International Whaling Commission
kHz	Kilohertz
km	Kilometers
m	Meter
MF	Mid-Frequency
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
μPA	Micropascal
MRA	Marine Resource Assessment
NEPA	National Environmental Policy Act
NITS	Noise-Induced Threshold Shift
NMFS	National Marine Fisheries Service
nm	Nautical Miles
NOAA	National Oceanic and Atmospheric Administration
OAML	Oceanographic and Atmospheric Master Library
PEA	Programmatic Environmental Assessment
PCIMAT	Personal Computer Interactive Multisensor Analysis Trainer
PMRF	Pacific Missile Range Facility
PTS	Permanent Threshold Shift
RIMPAC	Rim of the Pacific
SAG	Surface Action Group
SPL	Sound Pressure Level
SURTASS LFA	Surveillance Towed Array Sensor System Low Frequency Active
TS	Threshold Shift
TTS	Temporary Threshold Shift

EXECUTIVE SUMMARY

With this submittal, the U.S. Navy requests an Incidental Harassment Authorization (IHA) for the incidental harassment of marine mammals incidental to the Rim of the Pacific (RIMPAC) Exercise training events within the Hawaiian Islands Operating Area during RIMPAC 2006, as permitted by the Marine Mammal Protection Act (MMPA) of 1972, as amended. The training events may expose certain marine mammals that may be present within the Hawaiian Islands Operating Area to sound from mid-frequency hull mounted active tactical sonar.

As a combined force, submarines, surface ships, and aircraft will conduct Antisubmarine Warfare (ASW) against opposition submarine targets. Submarine targets include real submarines, target drones that simulate the operations of an actual submarine, and virtual submarines interjected into the training events by exercise controllers. ASW training events are complex and highly variable. For RIMPAC the primary event involves a Surface Action Group (SAG), consisting of one to five surface ships equipped with sonar, with one or more helicopters, and a P-3 searching for one or more submarines.

The potential exposures outlined in Chapter 6 represent the maximum expected number of animals that could be affected. The Navy routinely employs a number of protective measures, outlined in Chapter 11, which will substantially decrease the number of animals potentially affected. Also, the use of conservative analyses serves as an additional mitigation technique.

In order to estimate acoustic exposures from the RIMPAC ASW training events, acoustic sources to be used were examined with regard to their operational characteristics. An analysis was conducted for RIMPAC 2006, modeling the potential interaction of hull mounted mid-frequency active tactical sonar with marine mammals in the Hawaiian Islands Operating Area. The modeling occurred in five broad steps, listed below. Results were calculated based on the typical ASW activities planned for RIMPAC 2006. Acoustic propagation and mammal population data are analyzed for the July timeframe since RIMPAC occurs in July.

Step 1. Perform a propagation analysis for the area ensonified using spherical spreading loss and the Navy's CASS/GRAB program, respectively.

Step 2. Convert the propagation data into a two-dimensional acoustic footprint for the acoustic sources engaged in each training event as they move through the six acoustic exposure model areas.

Step 3. Calculate the total energy flux density level for each ensonified area summing the accumulated energy of all received pings.

Step 4. Compare the total energy flux density to the thresholds and determine the area at or above the threshold to arrive at a predicted marine mammal exposure area.

Step 5. Multiply the exposure areas by the corresponding mammal population density estimates. Sum the products to produce species sound exposure rate. Analyze this rate based on the annual number of events for each exercise scenario to produce annual acoustic exposure estimates.

The modeled estimate indicates the potential for a total of 33,331 Level B harassment exposures. Level B harassment in the context of military readiness activities is defined as any

1 act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by
2 causing disruption of natural behavioral patterns including, but not limited to, migration,
3 surfacing, nursing, breeding, feeding, or sheltering **to a point where such behavioral patterns**
4 **are abandoned or significantly altered.** This estimate of total predicted marine mammal sound
5 exposures constituting Level B harassment, is presented *without* an assessment of whether those
6 exposures would cause behavioral patterns to be abandoned or significantly altered and *without*
7 consideration of standard protective operating procedures. There are no predicted marine
8 mammal sonar exposures that would result in injury. However, the Level B harassment
9 predicted for beaked whales is treated as non-lethal Level A harassment.

10
11 The sound energy level threshold for determining when an exposure constitutes Level B
12 harassment was determined in consultation with NMFS as a cooperating agency. Although Navy
13 believes there is a firm scientific basis for setting this threshold at 190 dB re 1 $\mu\text{Pa}^2\text{-s}$ EL (see
14 Section 6.2.4.2 for a full discussion), the use of the 173 dB re 1 $\mu\text{Pa}^2\text{-s}$ EL metric as threshold
15 was required by NMFS as a precautionary measure given this first attempt to quantitatively
16 predict the potential effects of mid-frequency sonar on marine mammals.

17
18 Based on the widely dispersed RIMPAC locations, and consideration of the estimated behavioral
19 disturbance levels, each potentially affected marine mammal species was reviewed relative to
20 recruitment and survival. In all cases the conclusions are that the proposed RIMPAC ASW
21 training events would have a negligible impact on marine mammals, and that no strategic marine
22 mammal stocks would be affected. Modeling indicates that sperm, fin, and sei whales and monk
23 seals are the only endangered species with potential for incidental harassment; however, given
24 standard protective measures it is not likely RIMPAC training will disrupt sperm, fin, and sei
25 whale and monk seal natural behavioral patterns to a point where such behaviors are abandoned
26 or significantly altered. In accordance with ESA requirements, the Navy has initiated Formal
27 Section 7 coordination with NMFS given there is a potential that RIMPAC ASW training events
28 may affect but are not likely to adversely affect sperm, fin, or sei whales or monk seals.

29
30 The information and analyses provided in this application are presented to fulfill the IHA
31 requirements in Paragraphs (1) through (11) of 50 Code of Federal Regulations (CFR)
32 § 228.4(a).

1. DESCRIPTION OF ACTIVITIES

This Chapter describes the mission activities conducted during Rim of the Pacific (RIMPAC) 2006 that could result in harassment under the Marine Mammal Protection Act (MMPA) of 1972, as amended. The actions are Navy training events involving mid-frequency active tactical sonar with the potential to affect marine mammals that may occur within the Hawaiian Islands Operating Area.

1.1 Background

RIMPAC is a biennial, sea control/power projection fleet exercise that has been performed since 1968. RIMPAC 2006 will be the twentieth RIMPAC. A RIMPAC Programmatic Environmental Assessment (PEA) was prepared in 2002 by Commander, THIRD Fleet for future RIMPAC exercises. The RIMPAC PEA analyzed the potential environmental effects of RIMPAC, including in-port operations, command and control, aircraft operations, ship maneuvers, amphibious landings, troop movements, gunfire and missile exercises, submarine and antisubmarine exercises, mining and demolition activities, hulk sinking exercise, salvage, special warfare, and humanitarian operations. The RIMPAC PEA identified the Proposed Action as the set of training events and locations that could be used for future RIMPAC exercises.

The RIMPAC PEA addressed all reasonably foreseeable activities in the particular geographical areas affected by the Proposed Action and focused on the activities with reasonable potential for impacts on the environment. It was determined that because training events would take place at existing facilities and ranges routinely used for these types of activities, transportation and utilities would not be impacted and were not analyzed in the RIMPAC PEA. The environmental impacts were analyzed for the following resource areas: air quality, airspace, biological resources, cultural resources, geology and soils, hazardous materials and waste, land use, noise, safety and health, socioeconomics, and water resources. The Commander, Pacific Fleet (COMPACFLT) concluded that RIMPAC 2002 and future RIMPAC exercises would not significantly impact the environment based on the PEA analysis and the history of the previous RIMPAC exercises that had been conducted prior to 2002.

In June 2004, a supplement ("2004 Supplement") was prepared to analyze a set of proposed RIMPAC training events that were not addressed in the RIMPAC PEA. Those exercises included mine countermeasures, gunnery exercises, demolition exercises, and an experimental oceanographic sensing platform. COMPACFLT concluded that RIMPAC, including the additional activities proposed for 2004 and subsequent RIMPAC exercises, would not have a significant effect on the environment.

Section 1.5 of the RIMPAC PEA included a requirement that prior to each future RIMPAC, a review of the proposed activities would be compared to the analysis in the PEA to ensure all proposed activities are addressed. If new installations or facilities are proposed, significantly different training levels (personnel and equipment) and types of equipment are deployed, or the installation or range environmental sensitivities change, additional reviews or new analyses would be performed. Federal and state agencies would be briefed on the findings of each review

1 and any new analyses. Based on satisfactory analyses, coordination, and review, the decision-
2 maker would sign and publish a new Finding of No Significant Impact for the RIMPAC exercise.

3
4 Pursuant to Section 1.5 of the RIMPAC PEA, a RIMPAC 2006 Supplement was prepared to
5 compare the proposed RIMPAC 2006 activities with those in the RIMPAC PEA and the 2004
6 Supplement, to provide analysis of potential environmental impacts from proposed training
7 events and new locations, and to analyze the cumulative effects.

8
9 The RIMPAC 2006 Supplement also includes additional analysis related to mid-frequency active
10 sonar. The training events being analyzed are not new and have taken place with no significant
11 changes over the previous 19 RIMPAC exercises. However, new scientific information has led
12 to the ability to quantitatively assess potential effects to marine mammals through the use of
13 newly derived threshold criteria. As a result of scientific advances in acoustic exposure effects-
14 analysis modeling on marine mammals, action proponents now have the ability to quantitatively
15 estimate cumulative acoustic exposure on marine mammals. The RIMPAC 2006 Supplement
16 documents an acoustic exposure effects-analysis on marine mammals that may be affected by the
17 RIMPAC training events that use mid-frequency active tactical sonar.

18 **1.2 Proposed RIMPAC Antisubmarine Warfare Operations**

19 The types of Antisubmarine Warfare (ASW) training conducted during RIMPAC include the use
20 of ships, submarines, aircraft, non-explosive exercise weapons, and other training related
21 devices.

22 **1.2.1 ASW Training Operations During RIMPAC**

23 RIMPAC 06 is scheduled to take place from June 26, 2006, through about July 28, 2006, with
24 ASW exercises planned on 21 days. As a combined force, submarines, surface ships, and
25 aircraft will conduct ASW against opposition submarine targets. Submarine targets include real
26 submarines, target drones that simulate the operations of an actual submarine, and virtual
27 submarines interjected into the training events by exercise controllers. ASW training events are
28 complex and highly variable. For RIMPAC, the primary event involves a Surface Action Group
29 (SAG), consisting of one to five surface ships equipped with sonar, with one or more helicopters,
30 and a P-3 aircraft searching for one or more submarines. There will be approximately four SAGs
31 for RIMPAC 2006. For the purposes of analysis, each SAG event is counted as an ASW
32 operation. There will be approximately 44 ASW operations during RIMPAC with an average
33 event length of approximately 12 hours.

34
35 One or more ASW events may occur simultaneously within the Hawaiian Islands Operating
36 Area. Each event was identified and modeled separately. If a break of more than 1 hour in ASW
37 operations occurred, then the subsequent event was modeled as a separate event. Training event
38 durations ranged from 2 hours to 24 hours. A total of 532 training hours were modeled for
39 RIMPAC acoustic exposures. This total includes all potential ASW training that is expected to
40 occur during RIMPAC.

1.2.2 Active Acoustic Devices

Tactical military sonars are designed to search for, detect, localize, classify, and track submarines. There are two types of sonars, passive and active:

- Passive sonars only listen to incoming sounds and, since they do not emit sound energy in the water, lack the potential to acoustically affect the environment.
- Active sonars generate and emit acoustic energy specifically for the purpose of obtaining information concerning a distant object from the received and processed reflected sound energy.

Modern sonar technology has developed a multitude of sonar sensor and processing systems. In concept, the simplest active sonars emit omnidirectional pulses (“pings”) and time the arrival of the reflected echoes from the target object to determine range. More sophisticated active sonar emits an omnidirectional ping and then rapidly scans a steered receiving beam to provide directional, as well as range, information. More advanced sonars transmit multiple preformed beams, listening to echoes from several directions simultaneously and providing efficient detection of both direction and range.

The tactical military sonars to be deployed in RIMPAC are designed to detect submarines in tactical operational scenarios. This task requires the use of the sonar mid-frequency (MF) range (1 kilohertz [kHz] to 10 kHz) predominantly.

The types of tactical acoustic sources that would be used in training events during RIMPAC are discussed in the following paragraphs.

- **Surface Ship Sonars.** A variety of surface ships participate in RIMPAC, including guided missile cruisers, destroyers, guided missile destroyers, and frigates. Some ships (e.g., aircraft carriers) do not have any onboard active sonar systems, other than fathometers. Others, like guided missile cruisers, are equipped with active as well as passive sonars for submarine detection and tracking. For purposes of the analysis, all surface ship sonars were modeled as equivalent to SQS-53 having the nominal source level of 235 decibels (dB) re $1\mu\text{Pa}^2\text{-s @ 1 m}$. Since the SQS-53 hull mounted sonar is the U.S. Navy’s most powerful surface ship hull mounted sonar, modeling this source is a conservative assumption tending towards an overestimation of potential effects. Sonar ping transmission durations were modeled as lasting 1 second per ping and omnidirectional. Actual ping durations will be less than 1 second, which is a conservative assumption that will overestimate potential exposures. The SQS-53 hull mounted sonar transmits at center frequencies of 2.6 kHz and 3.3 kHz. Effects analysis modeling used frequencies that are required in tactical deployments such as those during RIMPAC. Details concerning the tactical use of specific frequencies and the repetition rate for the sonar pings is classified but was modeled based on the required tactical training setting.
- **Submarine Sonars.** Submarine sonars are used to detect and target enemy submarines and surface ships. Because submarine active sonar use is very rare and in those rare instances, very brief, it is extremely unlikely that use of active sonar by submarines

would have any effect on marine mammals. Therefore, this type of sonar was not modeled for RIMPAC 2006.

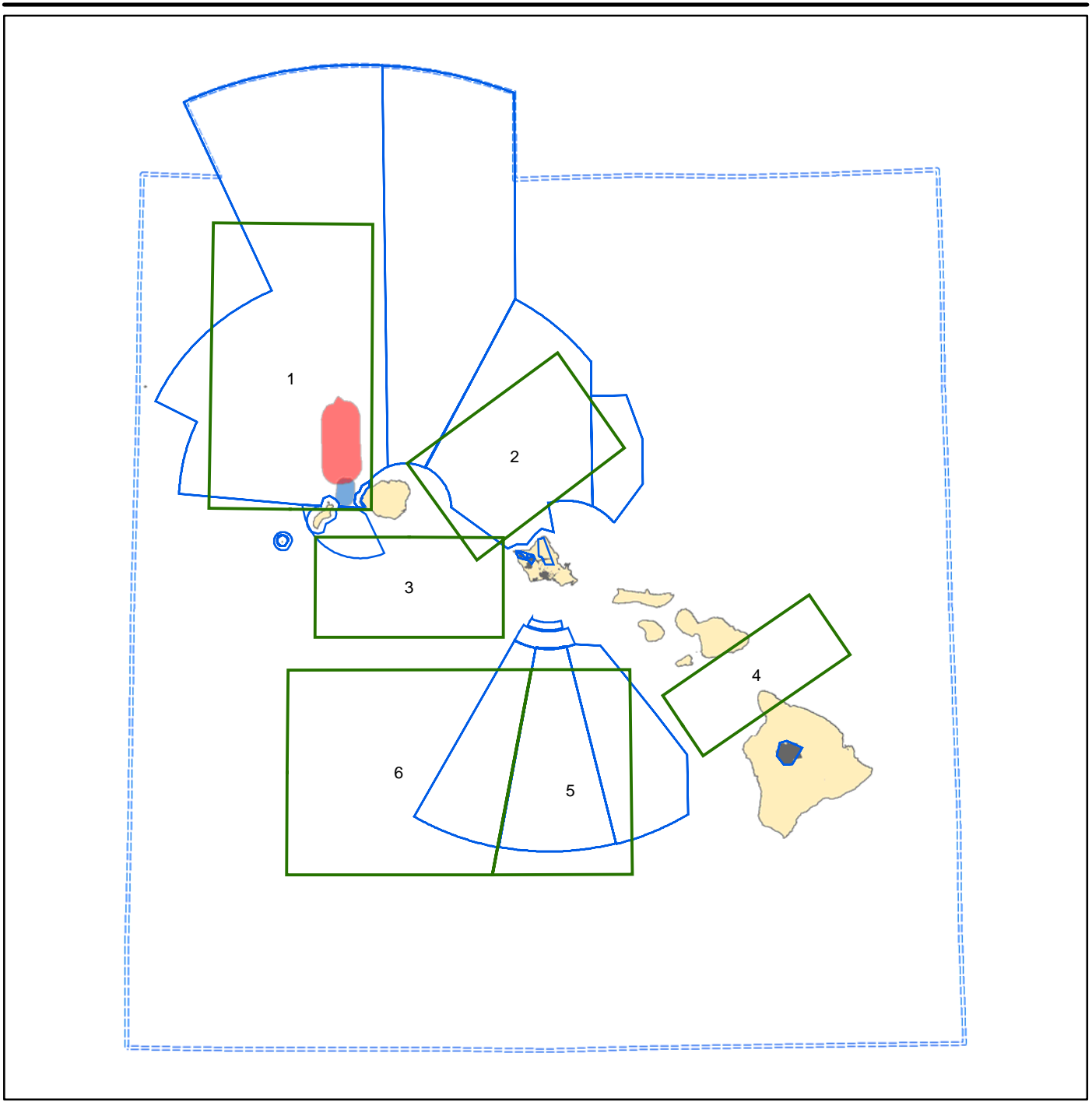
- **Aircraft Sonar Systems.** Aircraft sonar systems that would operate during RIMPAC include sonobuoys and dipping sonar. Sonobuoys may be deployed by P-3 aircraft or helicopters; dipping sonars are used by carrier-based helicopters. A sonobuoy is an expendable device used by aircraft for the detection of underwater acoustic energy and for conducting vertical water column temperature measurements. Most sonobuoys are passive, but some can generate active acoustic signals, as well as listen passively. Dipping sonar is an active or passive sonar device lowered on cable by helicopters to detect or maintain contact with underwater targets. During RIMPAC, these systems active modes are only used briefly for localization of contacts and are not used in primary search capacity. Because active mode dipping sonar use is very brief, it is extremely unlikely its use would have any effect on marine mammals. The AN/AQS 13 (dipping sonar) used by carrier based helicopters was determined in the *Environmental Assessment/Overseas Environmental Assessment of the SH-60R Helicopter/ALFS Test Program*, October 1999, not to be problematic due to its limited use and very short pulse length. Since 1999, during the time of the test plan, there have been over 500 hours of operation, with no environmental effects observed. Therefore, the aircraft sonar systems were not modeled for RIMPAC 2006.
- **Torpedoes.** Torpedoes are the primary ASW weapon used by surface ships, aircraft, and submarines. The guidance systems of these weapons can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, exploiting the emitted sound energy by the target, or actively, ensonifying the target and using the received echoes for guidance. All torpedoes used for ASW during RIMPAC would be located in the range area managed by PMRF and would be non-explosive and recovered after use. Potential impacts from the use of torpedoes on the PMRF range areas were analyzed in the PMRF EIS and, consistent with the National Oceanic and Atmospheric Administration's (NOAA's) June 3, 2002, Endangered Species Act Section 7 letter to the Navy for RIMPAC 2002, the Navy determined that the activities are not likely to adversely affect listed species under the jurisdiction of the National Marine Fisheries Service (NMFS).
- **Acoustic Device Countermeasures (ADC).** ADCs are, in effect, submarine simulators that make noise to act as decoys to avert localization and/or torpedo attacks. Previous classified analysis has shown that, based on the operational characteristics (source output level and/or frequency) of these acoustic sources, the potential to affect marine mammals was unlikely, and therefore they were not modeled for RIMPAC 2006.
- **Training Targets.** ASW training targets are used to simulate target submarines. They are equipped with one or a combination of the following devices: (1) acoustic projectors emanating sounds to simulate submarine acoustic signatures; (2) echo repeaters to simulate the characteristics of the echo of a particular sonar signal reflected from a specific type of submarine; and (3) magnetic sources to trigger magnetic detectors. Based on the operational characteristics (source output level and/or frequency) of these acoustic sources, the potential to affect marine mammals is unlikely, and therefore they were not modeled for RIMPAC 2006. Consistent with NOAA's June 3, 2002,

1 Endangered Species Act Section 7 letter to the Navy for RIMPAC 2002, the Navy
2 determined that the activities are not likely to adversely affect listed species under the
3 jurisdiction of the NMFS.








- 4 • **Range Sources.** Range pingers are active acoustic devices that allow each of the in-
5 water platforms on the range (e.g., ships, submarines, target simulators, and exercise
6 torpedoes) to be tracked by the range transducer nodes. In addition to passively tracking
7 the pinger signal from each range participant, the range transducer nodes also are capable
8 of transmitting acoustic signals for a limited set of functions. These functions include
9 submarine warning signals, acoustic commands to submarine target simulators (acoustic
10 command link), and occasional voice or data communications (received by participating
11 ships and submarines on range). Based on the operational characteristics (source output
12 level and/or frequency) of these acoustic sources, the potential to affect marine mammals
13 is unlikely, and therefore they were not modeled for RIMPAC 2006. Consistent with
14 NOAA's June 3, 2002, Endangered Species Act Section 7 letter to the Navy for RIMPAC
15 2002, the Navy determined that the activities are not likely to adversely affect listed
16 species under the jurisdiction of the NMFS.

18 **2. DURATION AND LOCATION OF THE ACTIVITIES**

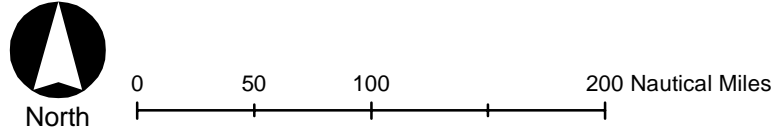
19 RIMPAC 06 is scheduled to take place from June 26, 2006, to about July 28, 2006, with ASW
20 training events planned on 21 days. Nearly all RIMPAC ASW training would occur in the six
21 areas delineated in Figure 2-1. ASW events typically rotate between these six ASW areas and
22 may continue while forces move between them. While ASW events could occur throughout the
23 approximate 210,000 square nautical miles (nmi) of the Hawaiian Islands Operating Area, most
24 events would occur within the approximate 46,000 square nmi of these six areas that were used
25 for analysis as being representative of the marine mammal habitats and the bathymetric, seabed,
26 wind speed, and sound velocity profile conditions within the entire Hawaiian Islands Operating
27 Area. For purposes of this analysis, all likely RIMPAC ASW events were modeled as occurring
28 in these six areas.



Explanation

- | | | | |
|---|---|---|---------------------|
|  | RIMPAC ASW Acoustic Effect Modeling Areas |  | BSURE Hydrophones |
|  | Hawaiian Islands Operating Area |  | BARSTUR Hydrophones |
|  | Special Use Airspace |  | Military |
| | |  | Land Area |

**RIMPAC ASW
Acoustic Exposure
Modeling Areas**



Hawaiian Islands

Figure 2-1

3. MARINE MAMMALS SPECIES AND NUMBERS

The information contained in this Chapter relies heavily on the data gathered in the Marine Resource Assessment (MRA) for the Hawaiian Islands Operating Area (DoN 2005a). Based on the MRA, there are 27 marine mammal species with possible or confirmed occurrence in the Hawaiian Islands Operating Area. As shown in Table 3-1, there are 25 cetacean species (whales, dolphins, and porpoises) and 2 pinnipeds (seals). In addition, five species of sea turtles are known to occur in the Hawaiian Islands Operating Area.

3.1 Marine Mammal Occurrence

The MRA data were used to provide a regional context for each species. The data were compiled from available sighting records, literature, satellite tracking, and stranding and bycatch data. The most abundant marine mammals are rough-toothed dolphins, dwarf sperm whales, and Fraser's dolphins; the most abundant large whales are sperm whales (Barlow 2003). There are three seasonally migrating baleen whale species that winter in Hawaiian waters including minke, fin, and humpback whales. Humpback whales utilize Hawaiian waters as a major breeding ground during winter and spring (November through April). Humpback whales should not be present during the RIMPAC exercise, which takes place in July. Because definitive information on the other two migrating species is lacking, their presence during the July timeframe was assumed, although it is unlikely.

Seven marine mammal species listed as federal endangered occur in the area, including the humpback whale, North Pacific right whale, sei whale, fin whale, blue whale, sperm whale, and Hawaiian monk seal. A separate consultation is underway with NMFS to evaluate potential effects to these species.

1 **Table 3-1 Marine Mammals that May Occur in the Hawaiian Islands Operating Area**

Order Cetacea	Scientific Name	Status	Occurs ¹	Group Size ²	Detection Probability ³		Overall Abundance
Suborder Mysticeti (baleen whales)							
Family Balaenidae (right whales)							
North Pacific right whale	<i>Eubalaena japonica</i>	E	Rare				
Family Balaenopteridae (rorquals)							
Humpback whale ⁴	<i>Megaptera novaeangliae</i>	E	Regular				
Minke whale	<i>Balaenoptera acutorostrata</i>		Rare				
Sei whale	<i>Balaenoptera borealis</i>	E	Rare	3.4	0.90	0.90	77
Fin whale	<i>Balaenoptera physalus</i>	E	Rare	2.6	0.90	0.90	174
Blue whale	<i>Balaenoptera musculus</i>	E	Rare				
Bryde’s whale	<i>Balaenoptera edini/brydei*</i>		Regular	1.5	0.90	0.90	493
Suborder Odontoceti (toothed whales)							
Family Physeteridae (sperm whale)							
Sperm whale	<i>Physeter macrocephalus</i>	E	Regular	7.8	0.87	0.87	7,082
Family Kogiidae (pygmy sperm whales)							
Pygmy sperm whale	<i>Kogia breviceps</i>		Regular	1.0	0.35	0.35	7,251
Dwarf sperm whale	<i>Kogia sima</i>		Regular	2.3	0.35	0.35	19,172
Family Ziphiidae (beaked whales)							
Cuvier’s beaked whale	<i>Ziphius cavirostris</i>		Regular	2.0	0.23	0.23	12,728
Blainville’s beaked whale	<i>Mesoplodon densirostris</i>		Regular	2.3	0.45	0.45	2,138
Longman’s beaked whale	<i>Indopacetus pacificus</i>		Regular	17.8	0.96	0.96	766
Family Delphinidae (dolphins)							
Rough-toothed dolphin	<i>Steno bredanensis</i>		Regular	14.8	0.74	1.00	19,904
Common bottlenose dolphin	<i>Tursiops truncatus</i>		Regular	9.5	0.74	1.00	3,263
Pantropical spotted dolphin	<i>Stenella attenuata</i>		Regular	60.0	0.77	1.00	10,260
Spinner dolphin	<i>Stenella longirostris</i>		Regular	29.5	0.77	1.00	2,804
Striped dolphin	<i>Stenella coeruleoalba</i>		Regular	37.3	0.77	1.00	10,385
Risso’s dolphin	<i>Grampus griseus</i>		Regular	15.4	0.74	1.00	2,351
Melon-headed whale	<i>Peponocephala electra</i>		Regular	89.2	0.74	1.00	2,947
Fraser’s dolphin	<i>Lagenodelphis hosei</i>		Rare	286.3	0.77	1.00	16,836
Pygmy killer whale	<i>Feresa attenuata</i>		Regular	14.4	0.74	1.00	817
False killer whale	<i>Pseudorca crassidens</i>		Regular	10.3	0.74	1.00	268
Killer whale	<i>Orcinus orca</i>		Regular	6.5	0.90	0.90	430
Short-finned pilot whale	<i>Globicephala macrorhynchus</i>		Regular	22.3	0.74	1.00	8,846
Order Carnivora							
Suborder Pinnipedia (seals, sea lions, walruses)							
Family Phocidae (true seals)							
Hawaiian monk seal	<i>Monachus scauinslandi</i>	E	Regular				
Northern elephant seal	<i>Mirounga angustirostris</i>		Rare				

3 Source: DoN 2005a, Barlow 2003

4 Notes:

5 Taxonomy follows Rice (1998) for pinnipeds and sirenians and IWC (2004) for cetaceans.

6 ¹ Occurrence: **Regular** = A species that occurs as a regular or normal part of the fauna of the area, regardless of how abundant or common it is;

7 **Rare** = A species that only occurs in the area sporadically; *includes more than one species, but nomenclature is still unsettled.

8 ² Mean group sizes are the geometric mean of best estimates from multiple observers and have not been corrected for bias.

9 ³ Barlow (2003).

10 ⁴ Humpback whale is included in the table although it is not expected to be present during the RIMPAC timeframe.

3.2 Estimated Marine Mammal Densities

Quantification of marine mammal distribution and abundance was accomplished by evaluating the spatial and temporal distribution and abundance of marine mammals throughout the Hawaiian Islands Marine Resource Assessment that includes the proposed RIMPAC ASW locations. Marine mammal survey data for the offshore area beyond 25 nautical miles (nm) (Barlow 2003) and survey data for near shore areas (within 25 nm; Mobley et. al, 2000) provided marine mammal species density for modeling (Table 3-2).

The Mobley densities are applicable for areas within 25 nm of land, and the densities from Barlow are appropriate for areas beyond 25 nm. To determine how to use the different densities, each RIMPAC ASW modeling area was examined to determine what percentage of the Hawaiian Islands Operating Area was within 25 nm of land. This was accomplished by using Nobeltec, a commercial visual navigational tool. The location of each RIMPAC ASW modeling area was placed on a map overlay. Circles with 25 nm radii were drawn from locations on the closest land masses. The percentage of the RIMPAC ASW modeling area within 25 nm of land was calculated. Table 3-3 presents these results. In the final calculation of the take estimates, the densities were applied with the same percentages. For example, in RIMPAC ASW Modeling Area 1, 10.3% of the RIMPAC ASW modeling area is within 25 nm of land. In calculating the harassment area for rough-toothed dolphin, 10.3% of the area used the density from Mobley and the remaining 89.7% of area used the density from Barlow.

To be conservative, no species present in Barlow (2003) or Mobley et al. (2000) were eliminated from consideration with the exception of humpback whales, which are not present in Hawaii during the July timeframe.

Table 3-2 Marine Mammal Density Estimates

Species	Offshore (Barlow, 2003)		Inshore (Mobley et al., 2000)	
	Density (animals/km ²)	CV (%)	Density (animals/km ²)	CV (%)
rough-toothed dolphin	0.0081	0.52	0.0017	62.8
dwarf sperm whale	0.0078	0.66	-	-
Fraser's dolphin	0.0069	1.11	-	-
Cuvier's beaked whale	0.0052	0.83	0.0006	51.2
spotted dolphin	0.0042	0.41	0.0407	45.1
striped dolphin	0.0042	0.48	0.0016	118.5
short-finned pilot whale	0.0036	0.49	0.0237	32.2
pygmy sperm whale	0.0030	0.77		
*sperm whale	0.0029	0.30	0.0010	56.0
bottlenose dolphin	0.0013	0.60	0.0103	55.7
melon-headed whale	0.0012	1.10	0.0021	88.3
spinner dolphin	0.0011	0.66	0.0443	36.5
Risso's dolphin	0.0010	0.65	-	-
Blainville's beaked whale	0.0009	0.77	0.0009	59.6
Longman's beaked whale	0.0003	1.05	-	-
pygmy killer whale	0.0003	1.12	-	-
Bryde's whale	0.0002	0.34	-	-
killer whale	0.0002	0.72	-	-
*fin whale	0.0001	0.72	-	-
false killer whale	0.0001	1.08	0.0017	47.3
*sei whale	0.0000	1.06	-	-
*blue whale	-	-	-	-
North Pacific right whale	-	-	-	-
minke whale	-	-	-	-
<i>Stenella</i> spp.	-	-	0.0076	64.6
unidentified dolphin	-	-	0.0134	41.0
unidentified beaked whale	0.0001	1.05	0.0005	97.1
unidentified cetacean	-	-	0.0004	72.3

*Endangered species

CV = Coefficient of Variation

Table 3-3 Percentage of Modeled Area Within 25 Nautical Miles of Land

Modeled Area	% within 25 nmi of land (Mobley)	% beyond 25 nmi of land (Barlow)
1	10.30%	89.70%
2	19.15%	80.85%
3	24.58%	75.42%
4	20.79%	79.21%
5	0.00%	100.00%
6	0.00%	100.00%

4. AFFECTED SPECIES STATUS AND DISTRIBUTION

Marine mammals inhabit most marine environments from deep ocean canyons to shallow estuarine waters. They are not randomly distributed. Marine mammal distribution is affected by demographic, evolutionary, ecological, habitat-related, and anthropogenic factors (Bowen et al. 2002; Bjørge 2002; Forcada 2002; Stevick et al. 2002). Subchapter 4.1 includes a general description of marine mammals that may occur in the RIMPAC ASW areas. Endangered marine mammals are presented first, with the remaining species following the order presented in Table 3-1.

Marine mammal movements are often related to feeding or breeding activity (Stevick et al. 2002). A migration is the periodic movement of all, or significant components of an animal population from one habitat to one or more other habitats and back again. Migration is an adaptation that allows an animal to monopolize areas where favorable environmental conditions exist for feeding, breeding, and/or other phases of the animal's life history. Some baleen whale species, such as humpback whales, make extensive annual migrations to low-latitude mating and calving grounds in the winter and to high-latitude feeding grounds in the summer (Corkeron and Connor 1999). Cetacean movements can also reflect the distribution and abundance of prey (Gaskin 1982; Payne et al. 1986; Kenney et al. 1996). Cetacean movements have also been linked to indirect indicators of prey, such as temperature variations, sea-surface chlorophyll-a concentrations, and features such as bottom depth (Fiedler 2002). Oceanographic conditions such as upwelling zones, eddies, and turbulent mixing can create regionalized zones of enhanced productivity that are translated into zooplankton concentrations, and/or entrain prey.

The oceanic waters surrounding the Hawaiian Islands do not contain a true continental shelf, and therefore no true shelf break—the region in which there is a sharp break in the slope of the island shelf (Kennett 1982; Thurman 1997). Rather, the Hawaiian Islands Operating Area and vicinity is composed of a series of volcanic seamounts, several of which have broken the surface to form the Hawaiian Islands. Seamount topography has been previously correlated with enhanced production due to the formation of vortices capable of mixing nutrients to the surface and entraining phytoplankton in the overlying waters (reviewed by Rogers 1994).

In addition, the passage of the North Equatorial Current through the Hawaiian archipelago is capable of creating regions of enhanced turbulence. Passage of the current of the North Equatorial Current can initiate the formation of eddies on the lee side of the islands (Wolanski et al. 2003); these are capable of entraining phytoplankton and creating localized regions of enhanced primary production. In addition, passage of currents through a narrow channel (as found in the Alenuhaha Channel between Hawaii and Maui) can create localized zones of turbulent flow capable of mixing nutrients into the surface layer to fuel primary production (Gilmartin and Revelante 1974; Simpson et al. 1982).

4.1 Threatened and Endangered Marine Mammals of the Hawaiian Islands Operating Area

There are seven marine mammal species that are listed as endangered under the Endangered Species Act (ESA) with confirmed or possible occurrence in the study area: humpback whale, North Pacific right whale, sei whale, fin whale, blue whale, sperm whale, and Hawaiian monk seal. Most of the cetacean species and the Hawaiian monk seal are expected to occur in the Hawaiian Islands Operating Area. As mentioned in Chapter 3.0, humpback whales are not believed to be present in the July timeframe. Because definitive information on sei and fin whales is lacking, their presence during the July timeframe was assumed, although it is unlikely. Each marine mammal species is described below with available distribution information related to the summer months when RIMPAC would occur.

4.1.1 Humpback Whale (*Megaptera novaeangliae*)

Humpback whales in Hawaiian waters are considered to be from the central North Pacific stock (Angliss and Lodge 2004). There are an estimated 4,005 (Coefficient of Variation [CV] = 0.095) individuals in this stock (Angliss and Lodge 2004). Estimates from Mobley et al. (2001), Calambokidis et al. (1997), and Baker and Herman (1981) suggest that the stock has increased in abundance.

Status—Humpback whales are classified as endangered under the ESA. There is no designated critical habitat for this species in the North Pacific. As an endangered species under the ESA, the humpback whale is designated as depleted under the MMPA and, as a result, is classified as a strategic stock (Angliss and Lodge 2004).

Distribution—Humpback whales utilize Hawaiian waters as a major breeding ground during winter and spring (November through April). Humpback whales should not be present during the RIMPAC exercise, which takes place in July. Peak abundance around the Hawaiian Islands is from late February through early April (Mobley et al. 2001; Carretta et al. 2005). During the fall-winter period, primary occurrence is expected from the coast to 50 nm (93 kilometers [km]) offshore, which takes into consideration both the available sighting data and the preferred breeding habitat (shallow waters) (Herman and Antinofa 1977; Mobley et al. 1999, 2000, 2001). The greatest densities of humpback whales (including calves) are in the four-island region consisting of Maui, Molokai, Kahoolawe, and Lanai, as well as Penguin Bank (Baker and Herman 1981; Mobley et al. 1999; Maldini 2003). Secondary occurrence is expected from seaward of this area, past the Hawaiian Islands Operating Area boundaries. Humpback whales are expected to be rare in Pearl Harbor, though it should be noted that an anomalous sighting of an adult and calf was reported during 1998 (DoN 2001a). The occurrence of humpback whales in deeper waters is based on work in the Caribbean (the breeding ground for humpback whales in the North Atlantic), where humpback whale calls were acoustically detected over deep water, far from any banks or islands (Swartz et al. 2002).

During the spring–summer period, secondary occurrence is expected offshore out to 50 nm (93 km), mainly to account for the possible occurrence of humpback whales during the end of the breeding season (April). Occurrence further offshore, as well as in Pearl Harbor, is expected to be rare.

4.1.2 North Pacific Right Whale (*Eubalaena japonica*)

Until recently, right whales in the North Atlantic and North Pacific were classified together as a single species, referred to as the “northern right whale.” Genetic data indicate that these two populations represent separate species: the North Atlantic right whale (*Eubalaena glacialis*) and the North Pacific right whale (*Eubalaena japonica*) (Rosenbaum et al. 2000).

Status—The North Pacific right whale is perhaps the world’s most endangered large whale species (Perry et al. 1999; IWC 2001). North Pacific right whales are classified as endangered both under the ESA and on the World Conservation Union (IUCN) Red List (Reeves et al. 2003). There are insufficient genetic or resighting data to address whether there is support for the traditional separation into eastern and western stocks (Brownell et al. 2001); however, Clapham et al. (2004) noted that north–south migratory movements support the hypothesis of two largely discrete populations of right whales in the eastern and western North Pacific. No reliable population estimate presently exists for this species; the population in the eastern North Pacific is considered to be very small, perhaps only in the tens of animals (NMFS 2002; Clapham et al. 2004), while in the western North Pacific, the population may number at least in the low hundreds (Brownell et al. 2001; Clapham et al. 2004). There is no proposed or designated critical habitat for the North Pacific right whale in the Hawaiian Islands Operating Areas (NMFS 2002).

Distribution—Right whales occur in sub-polar to temperate waters. The North Pacific right whale historically occurred across the Pacific Ocean north of 35 degrees north, with concentrations in the Gulf of Alaska, eastern Aleutian Islands, south-central Bering Sea, Sea of Okhotsk, and the Sea of Japan (Omura et al. 1969; Scarff 1986; Clapham et al. 2004). Presently, sightings are extremely rare, occurring primarily in the Okhotsk Sea and the eastern Bering Sea (Brownell et al. 2001; Shelden et al. 2005). Prior to 1996, right whale sightings were very rare in the eastern North Pacific (Scarff 1986; Brownell et al. 2001). Recent summer sightings of right whales in the eastern Bering Sea represent the first reliable consistent observations in this area since the 1960s (Tynan et al. 2001; LeDuc 2001). Right whales were probably never common along the west coast of North America (Scarff 1986; Brownell et al. 2001).

Neither the west coast of North America nor the Hawaiian Islands constituted a major calving ground for right whales within the last 200 years (Scarff 1986). No coastal calving grounds for right whales have been found in the western North Pacific either (Scarff 1986). Mid-ocean whaling records of right whales in the winter suggest that right whales may have wintered and calved far offshore in the Pacific (Scarff 1986, 1991; Clapham et al. 2004). Such pelagic calving would appear to be inconsistent with the records of nearshore calving grounds in other locales for the other right whale species.

There are very few recorded sightings from the Hawaiian Islands; they are from both shallow and deep waters (Herman et al. 1980; Rowntree et al. 1980; Salden and Mickelsen 1999). The highly endangered status of this species necessitates an extremely conservative determination of its occurrence (Jefferson personal communication 2005). Secondary occurrence is expected from the coastline to seaward of the Hawaiian Islands Operating Area boundaries. Right whales are not expected to make their way into lagoons or busy harbors; therefore, occurrence in Pearl Harbor is expected to be rare (Jefferson personal communication 2005). Right whale occurrence

patterns are assumed to be similar throughout the year. Based on migration patterns and whaling data, the Hawaiian Islands may have been a breeding ground for North Pacific right whales in the past (Clapham et al. 2004). Therefore, occurrence patterns would likely change in this area if the population were to increase substantially.

4.1.3 Fin Whale (*Balaenoptera physalus*)

Fin and sei whales are very similar in appearance, which has resulted in confusion about the distribution of both species (NMFS 1998a).

Status—Fin whales are classified as endangered under the ESA, and as a result, are considered to be depleted under the MMPA and are a strategic stock. There is no designated critical habitat for this species in the North Pacific. The IWC recognizes two management stocks in the North Pacific: a single widespread stock in the North Pacific and a smaller stock in the East China Sea (Donovan 1991). The National Oceanic and Atmospheric Administration (NOAA) stock assessment report recognizes three stocks of fin whales in the North Pacific: (1) the Hawaii stock; (2) the California/Oregon/Washington stock; and (3) the Alaska stock (Carretta et al. 2005). The best available estimate of abundance for the Hawaiian stock of the fin whale is 174 (CV = 0.72) individuals (Barlow 2003; Carretta et al. 2005).

Distribution—Fin whales are broadly distributed throughout the world's oceans, usually in temperate to polar latitudes, and less commonly in the tropics (Reeves et al. 2002). Fin whales are distributed across the North Pacific during the summer (May through October) from the southern Chukchi Sea (69°N) south to the Subarctic Boundary (approximately 42°N) and to 30°N in the California Current (Mizroch et al. 1999). They have been observed during the summer in the central Bering Sea (Moore et al. 2000).

Fin whales are not common in the Hawaiian Islands. Sightings were reported north of Oahu in May 1976, the Kauai Channel in February 1979, and north of Kauai during February 1994 (Shallenberger 1981; Mobley et al. 1996). Thompson and Friedl (1982) suggested that fin whales migrate into Hawaiian waters mainly during fall and winter, based on acoustic recordings off the islands of Oahu and Midway (Northrop et al. 1971; McDonald and Fox 1999). Primary occurrence is expected seaward of the 100 m isobath during the fall-winter period to account for possible stragglers migrating through the area. There is a rare occurrence for the fin whale from the shore to the 100 m isobath. There is a rare occurrence of fin whales throughout the Hawaiian Islands during the spring-summer period.

4.1.4 Sei Whale (*Balaenoptera borealis*)

Sei whales are extremely similar in appearance to Bryde's whales, and it is difficult to differentiate them at sea and even in some cases, on the beach (Mead 1977).

Status—The sei whale is listed as endangered under the ESA, and as a result is considered to be depleted under the MMPA and is a strategic stock. The International Whaling Commission (IWC) designates the entire North Pacific Ocean as one sei whale stock unit (Donovan 1991), although some evidence exists for multiple stocks (NMFS 1998a; Carretta et al. 2005). For the NOAA stock assessment reports, sei whales within the Pacific Exclusive Economic Zone (EEZ)

are divided into three discrete, non-contiguous areas: (1) the Hawaiian stock; (2) California/Oregon/Washington stock; and (3) the Eastern North Pacific (Alaska) stock (Carretta et al. 2005). The best available estimate of abundance is 77 (CV = 1.06) sei whales for the Hawaiian Islands EEZ (Barlow 2003; Carretta et al. 2005).

The taxonomy of the baleen whale group formerly known as sei and Bryde's whales is currently confused and highly controversial (see Reeves et al. 2004) for a recent review, also see the Bryde's whale species account below for further explanation).

Distribution—Sei whales have a worldwide distribution, but are found primarily in cold temperate to subpolar latitudes, rather than in the tropics or near the poles (Horwood 1987). Sei whales are also known for occasional irruptive occurrences in areas followed by disappearances for sometimes decades (Horwood 1987; Schilling et al. 1992; Clapham et al. 1997).

Sei whales spend the summer months feeding in the subpolar higher latitudes and return to the lower latitudes to calve in winter. There is some evidence from whaling catch data of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males (Horwood 1987; Perry et al. 1999). For the most part, the location of winter breeding areas remains a mystery (Rice 1998; Perry et al. 1999). In the North Pacific, sei whales are thought to occur mainly south of the Aleutian Islands. They are present all across the temperate North Pacific north of 40°N (NMFS 1998a) and are seen at least as far south as 20°N (Horwood 1987). In the east, they range as far south as Baja California, Mexico, and in the west, to Japan and Korea (Reeves et al. 1999). As noted by Reeves et al. (1999), reports in the literature from any time before the mid-1970s are suspect, because of the frequent failure to distinguish sei from Bryde's whales, particularly in tropical to warm temperate waters where Bryde's whales are generally more common than sei whales.

The sei whale is considered to be rare in Hawaiian waters based on reported sighting data and the species' preference for cool, temperate waters. Secondary occurrence is expected seaward of the 3,000 m isobath on the north side of the islands only. This pattern was based on sightings made during the NMFS–Southwest Fisheries Science Center shipboard survey assessment of Hawaiian cetaceans (see Barlow et al. 2004). Sei whales are expected to be rare throughout the remainder of the Hawaiian Islands Operating Area. Occurrence patterns are expected to be the same throughout the year.

4.1.5 Blue Whale (*Balaenoptera musculus*)

Blue whales are the largest living animals. This species is blue-gray with light (or sometimes dark) mottling.

Status—Blue whales are classified as endangered under the ESA and as a result, depleted under the MMPA and is a strategic stock. The blue whale was severely depleted by commercial whaling in the twentieth century (NMFS 1998b). There is no designated critical habitat for this species in the North Pacific. Acoustic data suggests that there are two stocks: the western North Pacific stock (that includes Hawaii) and the eastern North Pacific stock (Stafford et al. 2001; Stafford 2003). No estimate of abundance is available for the western North Pacific stock of the blue whale (Carretta et al. 2005).

Distribution—Blue whales are distributed from the ice edges to the tropics in both hemispheres (Jefferson et al. 1993). Blue whales as a species are thought to summer in high latitudes and move into the subtropics and tropics during the winter (Yochem and Leatherwood 1985). Data from both the Pacific and Indian Oceans, however, indicate that some individuals may remain in low latitudes year-round, such as over the Costa Rican Dome (Wade and Friedrichsen 1979; Reilly and Thayer 1990). The productivity of the Costa Rican Dome may allow blue whales to feed during their winter calving/breeding season and not fast, like humpback whales (Mate et al. 1999).

The only (presumably) reliable sighting report of this species in the central North Pacific was a sighting made from a scientific research vessel about 400 km northeast of Hawaii in January 1964 (NMFS 1998b). There is a rare occurrence for the blue whale throughout the year throughout the entire Hawaiian Islands Operating Area. Blue whale calls have been recorded off Midway and Oahu (Northrop et al. 1971; Thompson and Friedl 1982; McDonald and Fox 1999); these provide evidence of blue whales occurring within several hundred kilometers of these islands (NMFS 1998b). The recordings made off Oahu showed bimodal peaks throughout the year, suggesting that the animals were migrating into the area during summer and winter (Thompson and Friedl 1982; McDonald and Fox 1999). The greatest likelihood of encountering blue whales would be in waters greater than 100 m, based on observations in locales that blue whales are seen regularly (e.g., Schoenherr 1991).

4.1.6 Sperm Whale (*Physeter macrocephalus*)

The sperm whale is the largest toothed whale species.

Status—The sperm whale is classified as endangered under the ESA and, as a result, depleted under the MMPA and is a strategic stock. There is no designated critical habitat for this species in the North Pacific. Although many sperm whale populations have been depleted to varying degrees by past whaling activities, sperm whales remain one of the more globally common great whale species. In fact, in some areas, they are actually quite abundant. For example, there are estimated to be about 21,200 to 22,700 sperm whales in the eastern tropical Pacific Ocean (Wade and Gerrodette 1993).

For management purposes, the IWC has divided the North Pacific into two management regions defined by a zig-zag line which starts at 150°W at the equator, is at 160°W between 40° to 50°N, and ends up at 180°W north of 50°N (Donovan 1991). Preliminary genetic analyses reveal significant differences between sperm whales off the coast of California, Oregon, and Washington and those sampled offshore to the Hawaiian Islands (Mesnick et al. 1999; Carretta et al. 2005). The NOAA stock assessment report divides sperm whales within the U.S. Pacific EEZ into three discrete, noncontiguous areas: (1) waters around the Hawaiian Islands, (2) California, Oregon, and Washington waters, and (3) Alaskan waters (Carretta et al. 2005). The best available abundance estimate for the Hawaiian Islands stock of the sperm whale is 7,082 (CV = 0.30) individuals (Barlow 2003; Carretta et al. 2005). Sperm whale abundance in the eastern temperate North Pacific is estimated to be 32,100 individuals and 26,300 individuals by acoustic and visual detection methods, respectively (Barlow and Taylor 2005).

Distribution—Sperm whales are found from tropical to polar waters in all oceans of the world between approximately 70°N and 70°S (Rice 1998). Females use a subset of the waters where males are regularly found. Females are normally restricted to areas with sea surface temperatures greater than approximately 15°C, whereas males, especially the largest males, can be found in waters as far poleward as the pack ice within approximately to the 40° parallels (50° in the North Pacific) (Whitehead 2003).

Sperm whales are widely distributed throughout the Hawaiian Islands year-round (Rice 1960; Shallenberger 1981; Lee 1993; and Mobley et al. 2000). Sperm whale clicks recorded from hydrophones off Oahu confirm the presence of sperm whales near the Hawaiian Islands throughout the year (Thompson and Friedl 1982). Globally, sperm whales are typically distributed in waters over the shelf break and continental slope. The primary area of occurrence for the sperm whale is seaward of the shelf break in the Hawaiian Islands Operating Area. There is a rare occurrence of sperm whales from the shore to the shelf break. This occurrence prediction is based on the possibility of this typically deepwater species being found in insular shelf waters that are in such close proximity to deep water. Occurrence patterns are assumed to be similar throughout the year.

4.1.7 Hawaiian Monk Seal (*Monachus scauinslandi*)

Hawaiian monk seals are similar in body shape to female and young elephant seals, with a moderately robust, spindle-shaped body, and short muzzle. Adults are 2.1 to 2.4 m in length and weigh 170 to 240 kilograms, with females growing slightly larger than males (Gilmartin and Forcada 2002). Other than this size difference, there is little noticeable sexual dimorphism. Coloration of Hawaiian monk seals is drab, generally a yellow-brown to silvery-gray color with slight countershading and some small ventral white patches.

Status—The Hawaiian monk seal is listed as endangered under the ESA and depleted under the MMPA (Ragen and Lavigne 1999). The Hawaiian monk seal population is a NMFS strategic stock (Carretta et al. 2005). Hawaiian monk seals are managed as a single stock, although there are six main reproductive subpopulations at French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Island, and Kure Atoll (Ragen and Lavigne 1999; Carretta et al. 2005). Genetic comparisons between the Northwestern and Main Hawaiian Islands seals have not yet been conducted, but observed interchange of individuals among the regions is extremely rare, suggesting that these may be more appropriately designated as separate stocks; further research is needed (Carretta et al. 2005).

The best estimate of the total population size is 1,304 individuals (Carretta et al. 2005). There are an estimated 55 seals in the Main Hawaiian Islands (Baker and Johanos 2004; DoN 2005a; Carretta et al. 2005). The vast majority of the population is present in the Northwestern Hawaiian Islands. The trend in abundance for the population over the past 20 years has mostly been negative (Baker and Johanos 2004; Carretta et al. 2005). A self-sustaining subpopulation in the Main Hawaiian Islands may improve the monk seal's long-term prospects for recovery (MMC 2003; Baker and Johanos 2004; Carretta et al. 2005).

1 Critical habitat for the Hawaiian monk seal is designated from the shore out to 37 m (20
2 fathoms) in 10 areas of the Northwestern Hawaiian Islands (NMFS 1988). The eastern-most
3 island is located on the northwestern edge of the Hawaiian Islands Operating Area.
4

5 **Distribution**—The Hawaiian monk seal occurs only in the central North Pacific. Until recently,
6 this species occurred almost exclusively at remote atolls in the Northwestern Hawaiian Islands
7 where six major breeding colonies are located: French Frigate Shoals, Laysan and Lisianski
8 Islands, Pearl and Hermes Reef, Midway Island, and Kure Atoll. In the last decade, however,
9 sightings of Hawaiian monk seals in the Main Hawaiian Islands have increased considerably
10 (Baker and Johanos 2004; Carretta et al. 2005). Most monk seal haulout events in the Main
11 Hawaiian Islands have been on the western islands of Niihau and Kauai (Baker and Johanos
12 2004; Carretta et al. 2005), although sightings or births have now been reported for all of the
13 Main Hawaiian Islands, including Lehua Rock and Kaula Rock (MMC 2003; Baker and Johanos
14 2004). These sightings include “surplus” males that were relocated from the main breeding
15 islands to reduce the problem of mobbing of breeding females (Zevin 1995; Baker and Johanos
16 2004). Births of Hawaiian monk seal pups have been recorded in the Main Hawaiian Islands
17 including Kauai and Niihau (Baker and Johanos 2004). Hawaiian monk seals wander to Mar
18 Reef and Gardner Pinnacles and have occasionally been sighted on nearby island groups such as
19 Johnston Atoll, Wake Island, and Palmyra Atoll (Rice 1998).
20

21 Hawaiian monk seals show very high site fidelity to natal islands, with only about 10% of
22 individuals moving to another island in their lifetime (Gilmartin and Forcada 2002). While
23 monk seals do move between islands, long-distance movements are not common. Seals move
24 distances of up to 250 km on a regular basis, but distances of more than 1,000 km have not been
25 documented (DeLong et al. 1984; Ragen and Lavigne 1999).
26

27 The highly endangered status of this species necessitates a conservative estimate of expected
28 occurrence in the Hawaiian Islands Operating Area. Primary occurrence of monk seals is
29 expected in a continuous band between Nihoa, Kaula Rock, Niihau, and Kauai. This band
30 extends from the shore to around the 500 m isobath and is based on the large number of sightings
31 and births recorded in this area (Westlake and Gilmartin 1990; Ragen and Finn 1996; MMC
32 2003; Baker and Johanos 2004). An area of secondary occurrence is expected from the 500 m
33 isobath to the 1,000 m isobath around Nihoa, Kaula Rock, Niihau, and Kauai. A continuous area
34 of secondary occurrence is also expected from the shore to the 1,000 m isobath around the other
35 Main Hawaiian Islands, taking into account sighting records, the location of deepsea corals, and
36 the ability of monk seals to forage in water deeper than 500 m (Parrish et al. 2002; Severns and
37 Fiene Severns 2002; Kona Blue Water Farms 2003; Kubota 2004; Anonymous 2005; Fujimori
38 2005; Parrish personal communication). The Pearl Harbor entrance is included in the area of
39 secondary occurrence based on sightings of this species near the entrance of the harbor (DoN
40 2001b). There is a rare occurrence of the monk seal seaward of the 1,000 m isobath. Occurrence
41 patterns are expected to be the same throughout the year.
42

4.2 Other Marine Mammals of the Hawaiian Islands Operating Area

4.2.1 Minke Whale (*Balaenoptera acutorostrata*)

The minke whale is the smallest balaenopterid species in the North Pacific, with adults reaching lengths of just over 9 m (Jefferson et al. 1993).

Status—The IWC recognizes three stocks of minke whales in the North Pacific: one in the Sea of Japan/East China Sea, one in the rest of the western Pacific west of 180°N, and one in the remainder of the Pacific (Donovan 1991). For the NOAA stock assessment report, there are three stocks of minke whales within the U.S. Pacific EEZ: (1) a Hawaiian stock; (2) a California/Oregon/Washington stock; and (3) an Alaskan stock (Carretta et al. 2005). There currently is no abundance estimate for the Hawaiian stock of minke whales, which appears to occur seasonally (approximately November through March) around the Hawaiian Islands (Carretta et al. 2005).

Distribution—Minke whales are distributed in polar, temperate, and tropical waters (Jefferson et al. 1993); they are less common in the tropics than in cooler waters. Minke whales are present in the North Pacific from near the equator to the Arctic (Horwood 1990). The summer range extends to the Chukchi Sea (Perrin and Brownell 2002). In the winter, minke whales are found south to within 2° of the equator (Perrin and Brownell 2002). The distribution of minke whale vocalizations (specifically, “boings”) suggests that the winter breeding grounds are the offshore tropical waters of the North Pacific Ocean (Rankin and Barlow 2003). There is no obvious migration from low-latitude, winter breeding grounds to high-latitude, summer feeding locations in the western North Pacific, as there is in the North Atlantic (Horwood 1990); however, there are some monthly changes in densities in both high and low latitudes (Okamura et al. 2001). In the northern part of their range, minke whales are believed to be migratory, whereas they appear to establish home ranges in the inland waters of Washington and along central California (Dorsey et al. 1983) and exhibit site fidelity to these areas between years (Borggaard et al. 1999).

The minke whale is expected to occur seasonally in the Hawaiian Islands Operating Area (Barlow 2003). Abundance is expected to be higher between November and March (Carretta et al. 2005). Therefore, an area of secondary occurrence is seaward of the shoreline during the fall-winter period. Both visual and acoustic detections of minke whales have been reported for this area (e.g., Balcomb 1987; Thompson and Friedl 1982; Barlow et al. 2004; Carretta et al. 2005; Norris et al. 2005). The occurrence pattern takes into account both sightings in shallow waters in some locales globally as well as the anticipated oceanic occurrence of this species (Jefferson personal communication 2005). “Boings” were recorded in waters with a bottom depth of approximately 1,280 m to 3,840 m (Norris et al. 2005). Norris et al. (2005) reported sighting a minke whale 93 km southwest of Kauai, in waters with a bottom depth of approximately 2,560 m. During the spring-summer period, there is a rare occurrence for the minke whale throughout the entire Hawaiian Islands Operating Area.

4.2.2 Bryde's Whale (*Balaenoptera edenybrydei*)

Description—Bryde's whales can be easily confused with sei whales. It is not clear how many species of Bryde's whales there are, but genetic analyses suggest the existence of at least two species (Rice 1998; Kato 2002). The taxonomy of the baleen whale group formerly known as sei and Bryde's whales is currently confused and highly controversial (see Reeves et al. 2004 for a recent review).

Status—The IWC recognizes three management stocks of Bryde's whales in the North Pacific: western North Pacific, eastern North Pacific, and East China Sea (Donovan 1991). There is currently no biological basis for defining separate stocks of Bryde's whales in the central North Pacific (Carretta et al. 2005). For the NOAA stock assessment reports, Bryde's whales within the U.S. Pacific EEZ are divided into two areas: (1) Hawaiian waters, and (2) the eastern tropical Pacific (east of 150°W and including the Gulf of California and waters off California) (Carretta et al. 2005).

Distribution—The Bryde's whale is found in tropical and subtropical waters, generally not moving poleward of 40° in either hemisphere (Jefferson et al. 1993). Long migrations are not typical of Bryde's whales, though limited shifts in distribution toward and away from the equator, in winter and summer, respectively, have been observed (Cummings 1985). In summer, the distribution of Bryde's whales in the western North Pacific extends as far north as 40°N, but many individuals remain in lower latitudes, as far south as about 5°N. Data also suggest that winter and summer grounds partially overlap in the central North Pacific (Kishiro 1996; Ohizumi et al. 2002). Bryde's whales are also distributed in the central North Pacific in summer; the southernmost summer distribution of Bryde's whales inhabiting the central North Pacific is about 20°N (Kishiro 1996). Some whales remain in higher latitudes (around 25°N) in both winter and summer (Kishiro 1996).

Bryde's whales are seen year-round throughout tropical and subtropical waters (Kato 2002) and are also expected in the Hawaiian Islands Operating Area year-round (Jefferson personal communication 2005). It should be noted that more sightings are reported for the Northwest Hawaiian Islands than in the Main Hawaiian Islands (e.g., Barlow et al. 2004; Carretta et al. 2005). Bryde's whales have been reported to occur in both deep and shallow waters globally. There is a secondary occurrence of Bryde's whales seaward of the 50 m isobath in the Hawaiian Islands Operating Area. Bryde's whales are sometimes seen very close to shore and even inside enclosed bays (see Best et al. 1984). Occurrence is expected to be rare inshore of this area.

4.2.3 Pygmy and Dwarf Sperm Whales (*Kogia breviceps* and *Kogia sima*, respectively)

Dwarf and pygmy sperm whales are difficult for the inexperienced observer to distinguish from one another at sea, and sightings of either species are often categorized as *Kogia* spp. The difficulty in identifying pygmy and dwarf sperm whales is exacerbated by their avoidance reaction towards ships and change in behavior towards approaching survey aircraft (Würsig et al. 1998). Based on the cryptic behavior of these species and their small group sizes (much like that

of beaked whales), as well as similarity in appearance, it is difficult to identify these species in sightings at sea.

Status—Pygmy and dwarf sperm whales within the U.S. Pacific EEZ are each divided into two discrete, non-contiguous areas: (1) Hawaiian waters, and (2) waters off California, Oregon, and Washington (Carretta et al. 2005). The best available estimate of abundance for the Hawaiian stock of the pygmy sperm whale is 7,251 (CV = 0.77) individuals (Barlow 2003; Carretta et al. 2005). The best available estimate of abundance for the Hawaiian stock of the dwarf sperm whale is 19,172 individuals (CV = 0.66) (Barlow 2003; Carretta et al. 2005).

Distribution—Both *Kogia* species have a worldwide distribution in tropical and temperate waters (Jefferson et al. 1993).

Both species of *Kogia* generally occur in waters along the continental shelf break and over the continental slope (e.g., Baumgartner et al. 2001; McAlpine 2002; Baird 2005). The primary occurrence for *Kogia* is seaward of the shelf break in the Hawaiian Islands Operating Area. This takes into account their preference for deep waters. There is a rare occurrence for *Kogia* inshore of the area of primary occurrence. Occurrence is expected to be the same throughout the year.

4.2.4 Beaked Whales (Family Ziphiidae)

Seven species of beaked whales are known to occur in the North Pacific Ocean (MacLeod et al. in press); only three are expected to occur in the Hawaiian Islands Operating Area: Cuvier's beaked whale, Blainville's beaked whale (*Mesoplodon densirostris*), and Longman's beaked whale. Of these species, only the Cuvier's beaked whale is relatively easy to identify.

Status—The best available estimate of abundance for the Hawaiian stock of the Cuvier's beaked whale is 12,728 (CV = 0.83) individuals (Barlow 2003; Carretta et al. 2005). The best available estimate of abundance for the Hawaiian stock of the Blainville's beaked whale is 2,138 individuals (CV = 0.77) (Barlow 2003; Carretta et al. 2005). The best available estimate of abundance for the Hawaiian stock of the Longman's beaked whale is 766 (CV = 1.05) individuals (Barlow 2003; Carretta et al. 2005).

Distribution—The Cuvier's beaked whale is the most widely distributed of all beaked whale species, occurring in all three major oceans and most seas (Heyning 1989). This species occupies almost all temperate, subtropical, and tropical waters, as well as subpolar and even polar waters in some areas (MacLeod et al. in press).

The Blainville's beaked whale occurs in temperate and tropical waters of all oceans (Jefferson et al. 1993). The distribution of *Mesoplodon* species in the western North Atlantic may relate to water temperature (Mead 1989; MacLeod 2000), with Blainville's beaked whale generally occurring in warmer southern waters (MacLeod 2000). In the eastern Pacific, where there are about a half-dozen *Mesoplodon* species known, the Blainville's beaked whale is second only to the pygmy beaked whale (*Mesoplodon peruvianus*) in abundance in tropical waters (Wade and Gerrodette 1993).

Longman's beaked whale is known from tropical waters of the Pacific and Indian Oceans (Pitman et al. 1999; Dalebout et al. 2003). Ferguson and Barlow (2001) reported that all Longman's beaked whale sightings were south of 25°N.

The area of primary occurrence is seaward of the shelf break. A narrow band of secondary occurrence extends from the 50 m isobath to the 200 m isobath, which takes into account that deep waters come very close to the shore in this area. There is a rare occurrence for beaked whales from the shore to the 50 m isobath, since sightings in more shallow waters could occur. Occurrence patterns are expected to be the same throughout the year. It should be noted that there have been resightings of some photo-identified Blainville's and Cuvier's beaked whales from the island of Hawaii (Carretta et al. 2005).

4.2.5 Rough-Toothed Dolphin (*Steno bredanensis*)

This is a relatively robust dolphin with a cone-shaped head and the only one with no demarcation between the melon and beak (Jefferson et al. 1993). The rough-toothed dolphin reaches 2.8 m in length (Jefferson et al. 1993).

Status—Nothing is known about stock structure for the rough-toothed dolphin in the North Pacific (Carretta et al. 2005). The best available estimate of abundance for the Hawaiian stock of the rough-toothed dolphin is 19,904 (CV = 0.52) individuals (Carretta et al. 2005).

Distribution—Rough-toothed dolphins are found in tropical to warm-temperate waters globally, rarely ranging north of 40°N or south of 35° (Miyazaki and Perrin 1994). In the Main Hawaiian Islands, this species appears to demonstrate site fidelity to specific islands (Baird personal communication 2005).

Primary occurrence for the rough-toothed dolphin is from the shelf break to seaward of the Hawaiian Islands Operating Area boundaries. There is also an area of rare occurrence of rough-toothed dolphins from the shore to the shelf break. This takes into consideration the possibility of encountering rough-toothed dolphins in more shallow waters, based on distribution patterns for this species in other tropical locales, as well as Baird et al. (2003) noting that rough-toothed dolphins are rarely seen in nearshore waters of the Main Hawaiian Islands. Occurrence patterns are expected to be the same throughout the year.

4.2.6 Common Bottlenose Dolphin (*Tursiops truncatus*)

Bottlenose dolphins (genus *Tursiops*) are medium-sized, relatively robust dolphins that vary in color from light gray to charcoal. *Tursiops* is named for its short, stocky snout that is distinctively set off from the melon by a crease (Jefferson et al. 1993).

Genetic analyses of biopsied bottlenose dolphins in the Main Hawaiian Islands revealed one animal with a mitochondrial haplotype typical of the Indo-Pacific bottlenose dolphin, which suggests the possibility of two species of bottlenose dolphins in Hawaiian waters (Baird personal communication 2005). In the meantime, however, we present information on the one confirmed *Tursiops* species for this Hawaiian Islands Operating Area.

1 **Status**—The best available estimate of abundance for the Hawaiian stock of the bottlenose
2 dolphin is 3,263 (CV = 0.60) individuals (Barlow 2003; Carretta et al. 2005).

3
4 **Distribution**—The overall range of *Tursiops* is worldwide in tropical to temperate waters.
5 *Tursiops* generally do not range poleward of 45°, except around the United Kingdom and
6 northern Europe (Jefferson et al. 1993).

7
8 Bottlenose dolphins found in nearshore waters around the Main Hawaiian Islands are island-
9 associated, with all sightings occurring in relatively nearshore and shallow waters (<200 m), and
10 no apparent movement between the islands (Baird et al. 2002, 2003), though Baird et al. (2001)
11 noted the possibility that individuals could move between islands. Baird et al. (2003) noted the
12 possibility of a second population of bottlenose dolphins in the Hawaiian Islands, based on
13 sighting data, with a preference for deeper (bottom depth of 400 to 900 m) waters.

14
15 Bottlenose dolphins are regularly found around the Main Hawaiian Islands in both nearshore and
16 offshore waters (Rice 1960; Shallenberger 1981; Mobley et al. 2000; Baird et al. 2003). Based
17 on photo-identification studies and sighting data, there is a possibility of separate island
18 populations with different preferences for shallow (<200 m) and deep (400 to 900 m) waters
19 (Baird et al. 2003). Therefore, an area of primary occurrence is expected from the shore to the
20 1000 m isobath in the Hawaiian Islands Operating Area, excluding Nihoa due to no survey
21 effort. This area is continuous between Niihau and Kauai and between Oahu, Molokai, Lanai,
22 Maui, and Kahoolawe to account for possible movements between islands. There is a secondary
23 occurrence seaward of the 1,000 m isobath and seaward from the shoreline of Nihoa.

24 Occurrence patterns are expected to be the same throughout the year.

25 **4.2.7 Pantropical Spotted Dolphin (*Stenella attenuata*)**

26 The pantropical spotted dolphin is a generally slender dolphin. Adults may reach 2.6 m in length
27 (Jefferson et al. 1993).

28
29 **Status**—The best available estimate of abundance for the pantropical spotted dolphin within the
30 Hawaiian Islands EEZ is 10,260 (CV = 0.41) individuals (Barlow 2003; Carretta et al. 2005).

31
32 **Distribution**—The pantropical spotted dolphin is distributed in tropical and subtropical waters
33 worldwide (Perrin and Hohn 1994). Range in the central Pacific is from the Hawaiian Islands in
34 the north to at least the Marquesas in the south (Perrin and Hohn 1994).

35
36 Based on known habitat preferences and sighting data, the primary occurrence for the pantropical
37 spotted dolphin is between the 100 m and 4,000 m isobaths throughout the Hawaiian Islands
38 Operating Area. This area of primary occurrence also includes a continuous band connecting all
39 the Main Hawaiian Islands, Nihoa, and Kaula Rock, taking into account possible inter-island
40 movements. Secondary occurrence is expected from the shore to the 100 m isobath, as well as
41 seaward of the 4,000 m isobath. Pantropical spotted dolphins are expected to be rare in Pearl
42 Harbor. Occurrence patterns are the same throughout the year.

4.2.8 Spinner Dolphin (*Stenella longirostris*)

This is a slender dolphin that has a very long, slender beak. Adults can reach 2.4 m in length (Jefferson et al. 1993).

Status—The best available estimate of abundance for the Hawaiian stock of the spinner dolphin is 2,805 (CV = 0.66) individuals (Barlow 2003; Carretta et al. 2005).

Distribution—The spinner dolphin is found in tropical and subtropical waters worldwide. Limits are near 40°N and 40°S (Jefferson et al. 1993). These dolphins occur near islands such as the Hawaiian Islands, the Mariana Islands, the South Pacific, the Caribbean, and Fernando de Noronha Island off Brazil. Spinner dolphins have been documented to travel distances of 40 km between the Main Hawaiian Islands (Maldini 2003). Long-term studies of island-associated spinner dolphins in the Pacific have been conducted since the 1970s along the Kona coast of Hawaii (Norris et al. 1994; Östman 1994; Östman-Lind et al. 2004) and since the 1980s at Moorea, French Polynesia (Poole 1995). In the Hawaiian Islands, spinner dolphins occur along the leeward coasts of all the major islands and around several of the atolls northwest of the main island chain. Long-term site fidelity has been noted for spinner dolphins along the Kona coast of Hawaii, along Oahu, and off the island of Moorea in the Society Islands (Norris et al. 1994; Östman 1994; Poole 1995; Marten and Psarakos 1999), with some individuals being sighted for up to 12 years at Moorea (Poole 1995).

Spinner dolphins occur year-round throughout the Hawaiian Islands Operating Area, with primary occurrence from the shore to the 4,000 m isobath. This takes into account nearshore resting habitat and offshore feeding areas. Spinner dolphins are expected to occur in shallow water (50 m or less) resting areas throughout the middle of the day, moving into deep waters offshore during the night to feed. Primary resting areas are along the west side of Hawaii, including Makako Bay, Honokohau Bay, Kailua Bay, Kealahou Bay, Honaunau Bay, Kauhako Bay, and off Kahena on the southeast side of the island (Östman-Lind et al. 2004). Along the Waianae coast of Oahu, spinner dolphins rest along Makua Beach, Kahe Point, and Pokai Bay during the day (Lammers 2004). Kilauea Bay in Kauai is also a popular resting bay for Hawaiian spinner dolphins (Jefferson personal communication 2005). There is an area of secondary occurrence seaward of the 4,000 m isobath. Although sightings have been recorded around the mouth of Pearl Harbor (Lammers 2004), spinner dolphin occurrence is expected to be rare. Occurrence patterns are assumed to be the same throughout the year. It is currently not known whether individuals move between islands or island groups (Carretta et al. 2005).

4.2.9 Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin is uniquely marked with black lateral stripes from eye to flipper and eye to anus. This is a relatively robust dolphin with a long, slender beak and prominent dorsal fin reaching 2.6 m in length.

Status—The best available estimate of abundance for the Hawaiian stock of the striped dolphin is 10,385 (CV = 0.48) individuals (Barlow 2003; Carretta et al. 2005).

Distribution—The striped dolphin has a worldwide distribution in cool-temperate to tropical waters. This species is well documented in both the western and eastern Pacific off the coasts of Japan and North America (Perrin et al. 1994a); the northern limits are the Sea of Japan, Hokkaido, Washington state, and along roughly 40°N across the western and central Pacific (Reeves et al. 2002). Scattered records exist from the South Pacific as well (Perrin et al. 1994a).

The striped dolphin regularly occurs throughout the Hawaiian Islands Operating Area. There is a primary occurrence for the striped dolphin is seaward of the 1,000 m isobath based on sighting records and the species' known preference for deep waters. Striped dolphins are occasionally sighted closer to shore (Mobley et al. 2000); therefore, an area of secondary occurrence is expected from the 100 m to the 1,000 m isobaths. There is a rare occurrence from the shore to the 100 m isobath, including Pearl Harbor. Occurrence patterns are assumed to be the same throughout the year.

4.2.10 Risso's Dolphin (*Grampus griseus*)

Risso's dolphins are moderately large, robust dolphins reaching at least 3.8 m in length (Jefferson et al. 1993).

Status—The best available estimate of abundance for the Hawaiian stock of the Risso's dolphin is 2,351 (CV = 0.65) individuals (Barlow 2003; Carretta et al. 2005).

Distribution—The Risso's dolphin is distributed worldwide in tropical to warm-temperate waters, roughly between 60°N and 60°S, where surface water temperature is usually greater than 10°C (Kruse et al. 1999). Water temperature appears to be a factor that affects the distribution of Risso's dolphins in the Pacific (Kruse et al. 1999). Changes in local distribution and abundance along the California coast are probably in response to protracted or unseasonal warm-water events, such as El Niño events (Shane 1994).

There is an area of secondary occurrence between the 100 m and 5,000 m isobaths based on the known habitat preferences of this species, as well as the paucity of sightings even though there is extensive aerial and boat-based survey coverage near the islands. There is a narrow band of rare occurrence from the shore to the 100 m isobath, including Pearl Harbor, that takes into consideration the possibility that this species, with a preference for waters with steep bottom topography, might swim into areas where deep water is close to shore. Risso's dolphins are expected to be rare seaward of the 5,000 m isobath. Occurrence patterns are assumed to be the same throughout the year.

4.2.11 Melon-headed Whale (*Peponocephala electra*)

Melon-headed whales at sea closely resemble pygmy killer whales; both species have a blunt head with little or no beak. Melon-headed whales reach a maximum length of 2.75 m (Jefferson et al. 1993).

Status—The best available estimate of abundance for the Hawaiian stock of the melon-headed whale is 2,947 (CV = 1.11) individuals (Barlow 2003; Carretta et al. 2005).

Distribution—Melon-headed whales are found worldwide in tropical and subtropical waters. They have occasionally been reported from higher latitudes, but these sightings are often associated with incursions of warm water currents (Perryman et al. 1994). Preliminary results from photo-identification work in the Main Hawaiian Islands suggest inter-island movements by some individuals (e.g., between the islands of Kauai and Hawaii) as well as some residency by other individuals (e.g., at the island of Hawaii) (Baird personal communication).

The melon-headed whale is an oceanic species. Melon-headed whales are primarily expected to occur from the shelf break to seaward of the Hawaiian Islands Operating Area and vicinity. There is rare occurrence from the shore to the shelf break which would take into account any sightings that could occur closer to shore since deep water is very close to shore at these islands. Occurrence patterns are assumed to be the same throughout the year.

4.2.12 Fraser's Dolphin (*Lagenodelphis hosei*)

Description—The Fraser's dolphin reaches a maximum length of 2.7 m and is generally more robust than other small delphinids (Jefferson et al. 1993).

Status—The best available estimate of abundance for the Hawaiian stock of the Fraser's dolphin is 16,836 (CV = 1.11) individuals (Barlow 2003; Carretta et al. 2005).

Distribution—The Fraser's dolphin is found in tropical and subtropical waters around the world, typically between 30°N and 30°S (Jefferson et al. 1993). Strandings in temperate areas are considered extralimital and are usually associated with anomalously warm-water temperatures (Perrin et al. 1994b). As noted by Reeves et al. (1999), the documented distribution of this species is skewed towards the eastern Pacific, which may reflect the intensity of research associated with the tuna fishery rather than an actual higher density of occurrence there than in other tropical regions.

Fraser's dolphins have only recently been documented in Hawaiian waters (Carretta et al. 2005). Sightings have been recorded in the Northwest Hawaiian Islands but not within the Main Hawaiian Islands (Barlow 2003). There is a rare occurrence of the Fraser's dolphin from the shore to seaward of the Hawaiian Islands Operating Area that takes into account that this is an oceanic species that can be found closer to the coast, particularly in locations where the shelf is narrow and deep waters are nearby. Occurrence patterns are assumed to be the same throughout the year.

4.2.13 Pygmy Killer Whale (*Feresa attenuata*)

The pygmy killer whale is often confused with the melon-headed whale and the false killer whale. Pygmy killer whales reach lengths of up to 2.6 m (Jefferson et al. 1993).

Status—The best available estimate of abundance for the Hawaiian stock of the pygmy killer whale is 817 (CV = 1.12) individuals (Barlow 2003; Carretta et al. 2005).

Distribution—This species has a worldwide distribution in deep tropical and subtropical oceans. Pygmy killer whales generally do not range north of 40°N or south of 35°S (Jefferson et al.

1993). Reported sightings suggest that this species primarily occurs in equatorial waters, at least in the eastern tropical Pacific (Perryman et al. 1994). Most of the records outside the tropics are associated with strong, warm western boundary currents that effectively extend tropical conditions into higher latitudes (Ross and Leatherwood 1994).

Pygmy killer whales regularly occur in the Hawaiian Islands Operating Area. Pygmy killer whales are easily confused with false killer whales and melon-headed whales, which are two species that also have expected occurrence in the Hawaiian Islands study area. The pygmy killer whale is primarily expected to occur from the shelf break to seaward of the Hawaiian Islands Operating Area boundaries. There is a rare occurrence from the shore to the shelf break that takes into account any sightings that could occur just inshore of the shelf break, since deep water is very close to shore here. Occurrence patterns are assumed to be the same throughout the year. Pygmy killer whales off the island of Hawaii demonstrate tremendous site fidelity to the island (Baird personal communication).

4.2.14 False Killer Whale (*Pseudorca crassidens*)

The false killer whale is a large, dark gray to black dolphin with a faint gray patch on the chest and sometimes light gray areas on the head. Individuals reach maximum lengths of 6.1 m (Jefferson et al. 1993).

Status—The best available estimate of abundance for the Hawaiian stock of the false killer whale is 268 (CV = 1.08) individuals (Barlow 2003; Carretta et al. 2005). This stock is listed as a strategic stock by NMFS because the estimated level of serious injury and mortality from the Hawaii-based tuna and swordfish longline fishery is greater than the potential biological removal (Carretta et al. 2005). Genetic evidence suggests that the Hawaiian stock might be a reproductively isolated population from false killer whales in the eastern tropical Pacific (Chivers et al. 2003). Baird et al. (2005) noted that more work was needed to determine false killer whales using coastal waters might even be a discrete population from those in offshore waters and waters off the Northwest Hawaiian Islands.

Distribution—False killer whales are found in tropical and temperate waters, generally between 50°S and 50°N latitude with a few records north of 50°N in the Pacific and the Atlantic (Odell and McClune 1999). Seasonal movements in the western North Pacific may be related to prey distribution (Odell and McClune 1999). Baird et al. (2005) noted considerable inter-island movements of individuals in the Hawaiian Islands.

False killer whales are commonly sighted in nearshore waters from small boats and aircraft, as well as offshore from longline fishing vessels (e.g., Mobley et al. 2000; Baird et al. 2003; Walsh and Kobayashi 2004). Baird et al. 2005 reported that false killer whales in the Hawaiian Islands occur in waters from about 40 m to 4,000 m. There is an area of primary occurrence for the false killer whale from the shore to the 2,000 m isobath, with the exception of Pearl Harbor, where there is a rare occurrence for this species. There is an additional area of primary occurrence seaward of the 4,000 m isobath on the south side of the islands, which takes into account false killer whale sighting and bycatch data in the southwestern portion of the Hawaiian Islands Operating Area (Forney 2004; Walsh and Kobayashi 2004; Carretta et al. 2005). The area of secondary occurrence includes a narrow band between the 2,000 m and 4,000 m isobaths south

of the islands and the entire area north of the islands seaward of the 2,000 m isobath. It has been suggested that false killer whales using coastal waters might be a discrete population from those in offshore waters and waters off the Northwest Hawaiian Islands (Baird et al. 2005; Carretta et al. 2005). The area of secondary occurrence takes into account the possibility of two different stocks, with a possible hiatus in their distribution (Jefferson personal communication 2005). Occurrence patterns are assumed to be the same throughout the year.

4.2.15 Killer Whale (*Orcinus orca*)

This is probably the most instantly-recognizable of all the cetaceans. The killer whale is the largest member of the dolphin family.

Status—The best available estimate of abundance for the Hawaiian stock of the killer whale is 430 (CV = 0.72) individuals (Barlow 2003; Carretta et al. 2005). Genetic analysis of a biopsy sample taken from a killer whale in Hawaii (during the NMFS HICEAS survey) was most closely related to mammal-eating killer whales in Alaska (see Baird et al. 2003).

Distribution—The killer whale is a cosmopolitan species found throughout all oceans and contiguous seas, from equatorial regions to the polar pack-ice zones. This species has sporadic occurrence in most regions (Ford 2002). Though found in tropical waters and the open ocean, killer whales as a species are most numerous in coastal waters and at higher latitudes (Mitchell 1975; Miyazaki and Wada 1978; Dahlheim et al. 1982). Sightings in most tropical waters, although not common, are widespread (Visser and Bonaccorso 2003).

Killer whales in general are uncommon in most tropical areas (Jefferson personal communication 2005). The distinctiveness of this species would lead it to be reported more than any other member of the dolphin family, if it occurs in a certain locale. Killer whales are infrequently sighted and found stranded around the Hawaiian Islands (Shallenberger 1981; Tomich 1986; Mobley et al. 2001; Baird et al. 2003; Baird et al. in preparation), though with increasing numbers of boaters, sightings each year could be expected (Baird personal communication). Since the killer whale has a sporadic occurrence in tropical waters and can be found in both coastal areas and the open ocean, there is a rare occurrence of this species in the Hawaiian Islands Operating Area from the shoreline to seaward of the Hawaiian Islands Operating Area boundaries. Occurrence patterns are assumed to be the same throughout the year.

4.2.16 Short-Finned Pilot Whale (*Globicephala macrorhynchus*)

Pilot whales have bulbous heads with a forehead that sometimes overhangs the rostrum; there is little or no beak (Jefferson et al. 1993).

Status—The best available estimate of abundance for the Hawaiian stock of the short-finned pilot whale is 8,846 (CV = 0.49) individuals (Barlow 2003; Carretta et al. 2005). Stock structure of short-finned pilot whales has not been well-studied in the North Pacific Ocean, except in Japanese waters (Carretta et al. 2005). Two stocks have been identified in Japan based on pigmentation patterns and differences in the head shape of adult males (Kasuya et al. 1988). Pilot whales in Hawaiian waters are similar morphologically to the Japanese southern form (Carretta et al. 2005). Genetic analyses of tissue samples collected near the Main Hawaiian

Islands indicate that the Hawaiian population is reproductively isolated from short-finned pilot whales found in the eastern North Pacific Ocean (Carretta et al. 2005).

Distribution—The short-finned pilot whale is found worldwide in tropical to warm-temperate seas, generally in deep offshore areas. The short-finned pilot whale usually does not range north of 50°N or south of 40°S (Jefferson et al. 1993). The long-finned pilot whale is not known to presently occur in the North Pacific (Kasuya 1975); the range of the short-finned pilot whale appears to be expanding to fill the former range of the long-finned pilot whale (Bernard and Reilly 1999). Pilot whales are sighted throughout the Hawaiian Islands (e.g., Shallenberger 1981).

Short-finned pilot whales are expected to occur year-round throughout the Hawaiian Islands Operating Area. They are commonly found in deep waters with steep bottom topography, including deepwater channels between the Main Hawaiian Islands, such as the Alenuihaha Channel between Maui and Hawaii (Balcomb 1987). The area of primary occurrence for this species is between the 200 m and 4,000 m isobaths. Considering the narrow insular shelf and deep waters in close proximity to the shore, secondary occurrence is between the 50 m and 200 m isobaths. Another area of secondary occurrence extends from the 4,000 m isobath to seaward of the Hawaiian Islands Operating Area boundaries. Short-finned pilot whales are expected to be rare between the shore and the 50 m isobath. Occurrence patterns are assumed to be the same throughout the year. Photo-identification work suggests a high degree of site fidelity around the island of Hawaii (Shane and McSweeney 1990).

4.2.17 Northern Elephant Seal (*Mirounga angustirostris*)

The northern elephant seal is the largest pinniped in the Northern Hemisphere (the second-largest in the world, after the southern elephant seal *Mirounga leonina*).

Status—The northern elephant seal population has recovered dramatically after being reduced to several dozen to perhaps no more than a few animals in the 1890s (Bartholomew and Hubbs 1960; Stewart et al. 1994). Although movement and genetic exchange continues between rookeries, most elephant seals return to their natal rookeries when they start breeding (Huber et al. 1991). The California and Mexican breeding groups may be demographically isolated and are currently considered two separate stocks (Carretta et al. 2005).

The population size has to be estimated since all age classes are not ashore at any one time of the year (Carretta et al. 2005). There is a conservative minimum population estimate of 60,547 elephant seals in the California stock (Carretta et al. 2005). Based on trends in pup counts, abundance in California is increasing by around 6% annually, but the Mexican stock is evidently decreasing slowly (Stewart et al. 1994; Carretta et al. 2005).

Habitat Preference—Breeding and molting habitat for northern elephant seals is characterized by sandy beaches, mostly on offshore islands, but also in some mainland locations along the coast (Stewart et al. 1994). When on shore, seals will also use small coves and sand dunes behind and adjacent to breeding beaches (Stewart personal communication 2005). They rarely enter the water during the breeding season, but some seals will spend short periods in tide pools

1 and alongshore; these are most commonly weaned pups that are learning to swim (Le Boeuf et
2 al. 1972).

3
4 Feeding habitat is mostly in deep, offshore waters of warm temperate to subpolar zones (Stewart
5 and DeLong 1995; Stewart 1997; Le Boeuf et al. 2000). Some seals will move into subtropical
6 or tropical waters while foraging (Stewart and DeLong 1995).

7
8 **Distribution**—The northern elephant seal is endemic to the North Pacific Ocean, occurring
9 almost exclusively in the eastern and central North Pacific. However, vagrant individuals do
10 sometimes range to the western North Pacific. Northern elephant seals occur in Hawaiian waters
11 only rarely as extralimital vagrants. The most far-ranging individual appeared on Nijima Island
12 off the Pacific coast of Japan in 1989 (Kiyota et al. 1992). This demonstrates the great distances
13 that these animals are capable of covering.

14
15 There is a rare occurrence of northern elephant seals throughout the Hawaiian Islands Operating
16 Area year-round. There are several unconfirmed reports of elephant seals at Midway Atoll, Pearl
17 and Hermes Reef, and Kure Atoll (Antonelis personal communication). The first confirmed
18 sighting of a northern elephant seal in the Hawaiian Islands was a female found on Midway
19 Island in 1978 that had been tagged earlier at San Miguel Island (off the coast of southern
20 California) (NWAFC 1978). The first sighting of an elephant seal in the Main Hawaiian Islands
21 occurred on the Kona coast of Hawaii in January 2002; a juvenile male was sighted hauled out at
22 Kawaihae Beach and later at the Kona Village Resort (Fujimori 2002; Antonelis personal
23 communication 2004). Based on these sightings and documented long-distance movements as
24 far west as Japan (NWAFC 1978; Antonelis and Fiscus 1980; Tomich 1986; Kiyota et al. 1992;
25 Fujimori 2002), rare encounters with northern elephant seals in the Hawaiian Islands Operating
26 Area are possible.

27 28 29 **5. HARASSMENT AUTHORIZATION REQUESTED**

30 The Navy requests an Incidental Harassment Authorization (IHA) for the incidental harassment
31 of marine mammals pursuant to Section 101 (a)(5)(D) of the MMPA. The request is for hull
32 mounted mid-frequency active tactical sonar that was determined to expose marine mammals to
33 active sonar during RIMPAC ASW training events. RIMPAC 2006 is scheduled to occur from
34 about June 26, 2006 through about July 28, 2006.

35
36 It is understood that an IHA is applicable to activities that may result in harassment to marine
37 mammal species. The subsequent analysis in this request will identify Level B harassment as the
38 only form of harassment, without consideration of protective measures that will be followed.
39 The only exception is the post-modeling consideration that Level B harassment predicted for
40 beaked whales is treated as non-lethal Level A harassment.

6. NUMBERS AND SPECIES EXPOSED

The MMPA requires applicants to determine the number of marine mammals that are expected to be incidentally injured (Level A) or incidentally harassed (Level B) by the activity. The Proposed Action is a military readiness activity as defined in the MMPA, and Subchapter 6.2.2.2 below defines MMPA Level A and Level B as applicable to military readiness activities.

6.1 Non-Acoustic Effects

The RIMPAC PEA, 2004 Supplement, and 2006 Supplement concluded that the non-acoustic activities associated with RIMPAC activities would not have a significant impact on marine mammals, and that non-acoustic effects would not result in the take of MMPA-protected species.

Collisions with commercial and Navy ships can cause major wounds and may occasionally cause fatalities to sea turtles and cetaceans. The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale). Accordingly, the Navy has adopted standard operating procedures to reduce the potential for collisions with surfaced marine mammals and sea turtles. These standard operating procedures include: (1) use of lookouts trained to detect all objects on the surface of the water, including marine mammals and sea turtles; (2) reasonable and prudent actions to avoid the close interaction of Navy assets and marine mammals and sea turtles; and (3) maneuvering to keep away from any observed marine mammal. Based on these standard operating procedures, collisions with cetaceans and sea turtles are not expected.

6.2 Acoustic Exposures

The approach for estimating potential acoustic exposures from training activities on cetacean species is provided here to present the number and species of marine mammals for which incidental take authorization is requested.

Estimating potential acoustic exposures on cetaceans entails answering four questions:

- **What action will occur?** This requires identification of all acoustic sources that would be used in the exercises and the specific outputs of those sources. This information is summarized in Subchapter 6.2.3.
- **Where and when will the action occur?** The place, season, and time of the action are important to:
 - Determine which marine mammal species are likely to be present. Species occurrence and density data (Chapters 3 and 4) are used to determine the subset of marine mammals for consideration and to estimate the distribution of those species.
 - Predict the underwater acoustic environment that would be encountered. The acoustic environment here refers to environmental factors that influence the propagation of underwater sound.

- 1 • **Which potential acoustic exposures best define when harassment (injury or**
2 **behavioral disruption) occurs?** This requires potential exposures to be evaluated within
3 the context of the existing regulations. Subchapter 6.2.1 reviews the regulatory
4 framework and premises on which the effect analysis is based. Potential acoustic
5 exposures and their relationships to the definitions of harassment are also described in
6 Subchapter 6.2.1. Subchapters 6.2.2 and 6.2.3 describe the acoustic exposures that best
7 address current regulatory requirements and the criteria and thresholds for those
8 exposures.
- 9 • **How many marine mammals are predicted to be harassed?** Sound propagation
10 models are coupled with exposure thresholds and species distribution data to estimate the
11 number of marine mammals of each species that would likely be exposed to a specific
12 threshold. Subchapter 6.2.6 describes the modeling approach and acoustic exposure
13 estimates. Subchapter 6.2.7 presents the anticipated acoustic exposures to marine
14 mammals and the estimate of numbers and species for which incidental take authorization
15 is requested.

16 **6.2.1 Regulatory Framework**

17 A number of Navy actions and NOAA rulings have helped to qualify possible events deemed as
18 “harassment” under the MMPA. Note that “harassment” under the MMPA includes both
19 potential injury and disruptions of natural behavioral patterns to a point where they are
20 abandoned or significantly altered. The acoustic effects analysis and exposure calculations are
21 based on the following premises:

- 23 • Harassment that may result from Navy operations described in the 2006 Supplement to
24 the RIMPAC PEA is unintentional and incidental to those operations.
- 25 • The 2006 Supplement to the RIMPAC PEA uses an unambiguous definition of injury
26 developed in previous rulings (NOAA 2001, 2002): injury occurs when any biological
27 tissue is destroyed or lost as a result of the action.
- 28 • Behavioral disruption might result in subsequent injury and injury may cause a
29 subsequent behavioral disruption, so Level A and Level B (defined below) harassment
30 categories can overlap and are not necessarily mutually exclusive. However, by prior
31 ruling (NOAA 2001), the 2006 Supplement to the RIMPAC PEA assumes that Level A
32 and B harassment exist on a single continuum without overlap.
- 33 • An individual animal predicted to experience simultaneous multiple injuries, multiple
34 disruptions, or both, is counted as a single take (see NOAA 2001). An animal whose
35 behavior is disrupted by an injury has already been counted as a Level A take and will
36 not also be counted as a Level B take.
- 37 • The acoustic effects analysis is based on primary exposures of the action. Secondary, or
38 indirect, effects, such as susceptibility to predation following injury and injury resulting
39 from disrupted behavior, while possible, can only be reliably predicted in circumstances
40 where the responses have been well documented. Consideration of secondary effects
41 would result in much Level A harassment being considered Level B harassment, and vice
42 versa, since much injury (Level A harassment) has the potential to disrupt behavior
43 (Level B harassment), and much behavioral disruption (Level B) could be conjectured to

1 have the potential for injury (Level A). Consideration of secondary effects would lead to
2 circular definitions of harassment.

3 **6.2.2 Integration of Regulatory and Biological Frameworks**

4 This subchapter presents a **biological framework** within which potential effects can be
5 categorized and then related to the existing **regulatory framework** of injury (Level A) and
6 behavioral disruption (Level B). The information presented in Subchapters 6.2.3 and 6.2.4 is
7 used to develop specific numerical exposure thresholds. Exposure thresholds are combined with
8 sound propagation models and species distribution data to estimate the potential exposures, as
9 presented in Subchapter 6.2.7.

10 **6.2.2.1 Physiological and Behavioral Effects**

11 Sound exposure may affect multiple biological traits of a marine animal; however, the MMPA as
12 amended directs which traits should be used when determining effects. Effects that address
13 injury are considered Level A harassment under MMPA. Effects that address behavioral
14 disruption are considered Level B harassment under MMPA.

15
16 The biological framework proposed here is structured according to potential physiological and
17 behavioral effects resulting from sound exposure. Physiology and behavior are chosen over
18 other biological traits because:

- 19
20 • They are consistent with regulatory statements defining harm and harassment.
- 21 • They are components of other biological traits that may be relevant.
- 22 • They are a more sensitive and immediate indicator of effect.

23
24 For example, ecology is not used as the basis of the framework because the ecology of an animal
25 is dependent on the interaction of an animal with the environment. The animal's interaction with
26 the environment is driven both by its physiological function and its behavior, and an ecological
27 impact may not be observable over short periods of observation.

28
29 A “physiological effect” is defined here as one in which the “normal” physiological function of
30 the animal is altered in response to sound exposure. Physiological function is any of a collection
31 of processes ranging from biochemical reactions to mechanical interaction and operation of
32 organs and tissues within an animal. A physiological effect may range from the most significant
33 of impacts (i.e., mortality and serious injury) to lesser effects that would define the lower end of
34 the physiological impact range, such as the non-injurious distortion of auditory tissues. This
35 latter physiological effect is important to the integration of the biological and regulatory
36 frameworks and will receive additional attention in later subchapters.

37
38 A “behavioral effect” is one in which the “normal” behavior or patterns of behavior of an animal
39 are overtly disrupted in response to an acoustic exposure. Examples of behaviors of concern can
40 be derived from the harassment definitions in the MMPA and the ESA.

1 In this authorization request the term “normal” is used to qualify distinctions between
2 physiological and behavioral effects. Its use follows the convention of normal daily variation in
3 physiological and behavioral function without the influence of anthropogenic acoustic sources.
4 As a result, this authorization request uses the following definitions:

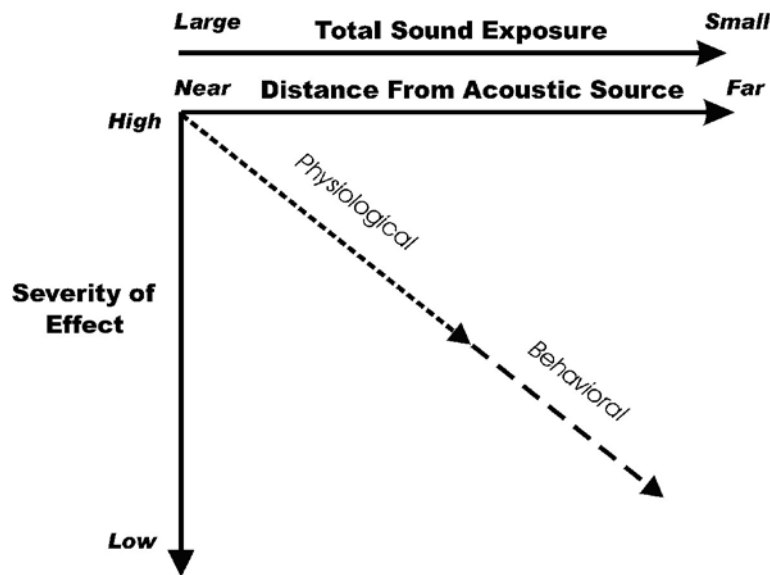
- 6 • A **physiological effect** is a variation in an animal’s physiology that results from an
7 anthropogenic acoustic exposure and exceeds the normal daily variation in
8 physiological function.
- 9 • A **behavioral effect** is a variation in an animal’s behavior or behavior patterns that
10 results from an anthropogenic acoustic exposure and exceeds the normal daily
11 variation in behavior, but which arises through normal physiological process (it
12 occurs without an accompanying physiological effect).

14 The definitions of physiological effect and behavioral effect used here are specific to this IHA
15 authorization request and should not be confused with more global definitions applied to the field
16 of biology.

18 It is reasonable to expect some physiological effects to result in subsequent behavioral effects.
19 For example, a marine mammal that suffers a severe injury may be expected to alter diving or
20 foraging to the degree that its variation in these behaviors is outside that which is considered
21 normal for the species. If a physiological effect is accompanied by a behavioral effect, the
22 overall effect is characterized as a physiological effect; physiological effects take precedence
23 over behavioral effects with regard to their ordering. This approach provides the most
24 conservative ordering of effects with respect to severity, provides a rational approach to dealing
25 with the overlap of the definitions, and avoids circular arguments.

27 The severity of physiological effects generally decreases with decreasing sound exposure and/or
28 increasing distance from the sound source. The same generalization does not consistently hold
29 for behavioral effects because they do not depend solely on the received sound level. Behavioral
30 responses also depend on an animal’s learned responses, innate response tendencies,
31 motivational state, the pattern of the sound exposure, and the context in which the sound is
32 presented. However, to provide a tractable approach to predicting acoustic effects that is
33 relevant to the terms of behavioral disruption described in the MMPA, it is assumed here that the
34 severities of behavioral effects also decrease with decreasing sound exposure and/or increasing
35 distance from the sound source. Figure 6-1 shows the relationship between severity of effects,
36 source distance, and exposure level, as defined in this authorization request.

Figure 6-1 Relationship Between Severity of Effects, Source Distance, and Exposure Level



6.2.2.2 MMPA Level A and Level B Harassment

Categorizing potential effects as either physiological or behavioral effects allows them to be related to the harassment definitions. For military readiness activities, Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. Injury, as defined in the RIMPAC 2006 Supplement and previous rulings (NOAA 2001, 2002), is the destruction or loss of biological tissue. The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue. For example, increased localized histamine production, edema, production of scar tissue, activation of clotting factors, white blood cell response, etc., may be expected following injury. Therefore, this authorization request assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and rulings (NOAA 2001), all injuries (slight to severe) are considered Level A harassment.

Public Law 108-136 (2004) amended the definition of Level B harassment for military readiness activities, which applies to this action. For military readiness activities, Level B harassment is now defined as “any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered.” Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause Level B harassment.

Replacement of the phrase “potential to disturb” in the non-military readiness definition with “disturbs” or “likely to disturb” indicates an intent to limit Level B takes for military readiness

activities to those activities that either actually cause a disturbance or have a greater than 50% probability of causing a disturbance.

The intent of the unique definition of harassment for military readiness activities was to provide greater clarity for the Department of Defense (DOD) and the regulatory agencies, and to properly focus authorization of military readiness and scientific research activities on biologically significant impacts to marine mammals, a science-based approach. Under the military readiness definition for "Level B Harassment," behavioral patterns should only be considered "abandoned" if long-term cessation of behaviors and demographic consequences to reproduction or survivability of the species or stock were involved. In order for natural behavioral patterns to be considered "significantly altered," there must be demographic consequences to reproduction or survivability of the species.

However, as described above and as required by NMFS as a Cooperating Agency, the analysis in this IHA assumes that short-term non-injurious sound exposure levels (SELs) predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. Application of this criterion assumes an effect even though it is highly unlikely that behavioral disruptions or instances of TTS will result in the abandonment or significant alteration of behavioral patterns. The Navy considers this overestimate of Level B harassment to be conservative because:

- There is no scientific correlation between mid-frequency sonar use and long-term abandonment or significant alteration of behavioral patterns in marine mammals in Hawaii.
- It is highly unlikely that a marine mammal (or group of animals) would experience any long-term effects because the proposed training makes individual mammals' repeated and/or prolonged exposures to high-level sonar signals unlikely given the 210,000 nmi² area of the Hawaiian Islands Operating Area where RIMPAC will occur. Specifically, mid-frequency sonars have limited marine mammal exposure ranges and relatively high platform speeds.

Some physiological effects can occur that are non-injurious but that can potentially disrupt the behavior of a marine mammal. These include temporary distortions in sensory tissue that alter physiological function, but that are fully recoverable without the requirement for tissue replacement or regeneration. For example, an animal that experiences a temporary reduction in hearing sensitivity suffers no injury to its auditory system, but may not perceive some sounds due to the reduction in sensitivity. As a result, the animal may not respond to sounds that would normally produce a behavioral reaction. This lack of response qualifies as a temporary disruption of normal behavioral patterns – the animal is impeded from responding in a normal manner to an acoustic stimulus. In this authorization request it is assumed that all temporary hearing impairment (slight to severe) is considered Level B harassment, even if the effect from the temporary impairment is biologically insignificant.

The harassment status of slight behavior disruption (without physiological effects) has been addressed in workshops, previous actions, and rulings (NOAA 1999, 2001; DoN 2002a). The conclusion is that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic event does not qualify as Level B harassment. A more general conclusion, that Level B

harassment occurs only when there is “a potential for a significant behavioral change or response in a biologically important behavior or activity,” is found in recent rulings (NOAA 2002).

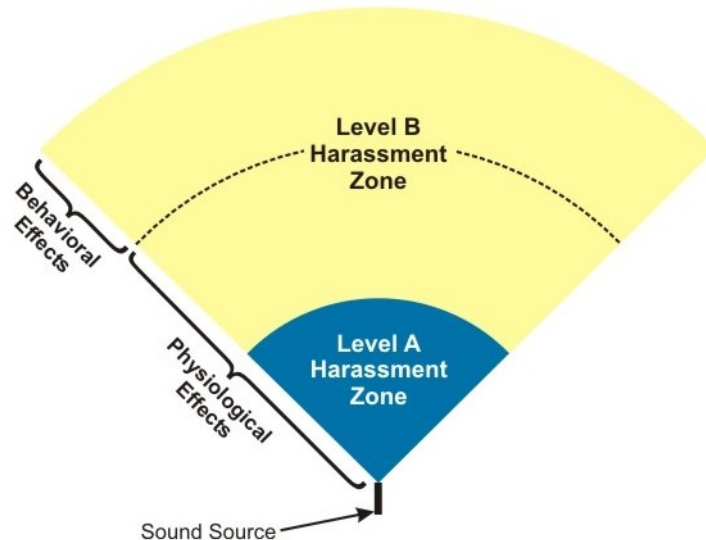
Although the temporary lack of response discussed above may not result in abandonment or significant alteration of natural behavioral patterns, the acoustic effects thresholds used in this authorization request assume that temporary hearing impairment (slight to severe) is considered Level B harassment. These conclusions and definitions, including the 2004 amendments to the definitions of harassment, were considered in developing conservative thresholds for behavioral disruption, as presented in Subchapter 6.2.4. These approaches overestimate the incidental take by harassment that may occur associated with this action.

6.2.2.3 MMPA Harassment Zones

The volumes of ocean in which Level A and Level B harassment is predicted to occur are described as **harassment zones**. As a conservative estimate, all marine mammals predicted to be in a zone are considered “taken” within the applicable harassment category. Figure 6-2 illustrates harassment zones extending from a hypothetical, directional sound source. (This figure is for illustrative purposes only and does not represent the sizes or shapes of the actual harassment zones)

The **Level A harassment zone** extends from the source out to the distance and exposure at which the slightest amount of injury is predicted to occur. The acoustic exposure that produces the slightest degree of injury is therefore the threshold value defining the outermost limit of the Level A harassment zone. Use of the threshold associated with the onset of slight injury as the most distant point and least injurious exposure takes account of all more serious injuries by inclusion within the Level A harassment zone. The threshold used to define the outer limit of the Level A harassment zone is given in Subchapter 6.2.3.

Figure 6-2 Harassment Zones Extending from a Hypothetical, Directional Sound Source



(This figure is for illustrative purposes only and does not represent the sizes or shapes of the actual harassment zones.)

The **Level B harassment zone** begins just beyond the point of slightest injury and extends outward from that point to include all animals that may possibly experience Level B harassment. Physiological effects extend beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurs, but without destruction or loss of that tissue. The animals predicted to be in this zone are assumed to experience Level B harassment by virtue of temporary impairment of sensory function (altered physiological function) that can disrupt behavior. The criterion and threshold used to define the outer limit of physiological effects leading to Level B harassment are given in Subchapter 6.2.3. Beyond that distance, the Level B harassment zone continues to the point at which no behavioral disruption is expected to occur. The criterion and threshold used to define the outer limit of the Level B harassment zone are given in Subchapter 6.2.4.

6.2.2.4 Auditory Tissues as Indicators of Physiological Effects

Exposure to continuous-type noise may cause a variety of physiological effects in mammals. For example, exposure to very high sound levels may affect the function of the visual system, vestibular system, and internal organs (Ward, 1997). Exposure to high-intensity, continuous-type sounds of sufficient duration may cause injury to the lungs and intestines (e.g., Dalecki et al., 2002). Sudden, intense sounds may elicit a “startle” response and may be followed by an orienting reflex (Ward, 1997; Jansen, 1998). The primary physiological effects of sound, however, are on the auditory system (Ward, 1997).

The mammalian auditory system consists of the outer ear, middle ear, inner ear, and central nervous system. Sound waves are transmitted through the outer and middle ears to fluids within the inner ear. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to over-stimulation by noise exposure (Yost 1994).

Very high sound levels may rupture the eardrum or damage the small bones in the middle ear (Yost 1994). Lower level exposures may cause permanent or temporary hearing loss; such an effect is called a noise-induced threshold shift (NITS), or simply a threshold shift (TS) (Miller, 1974). A TS may be either permanent, in which case it is called a permanent threshold shift (PTS), or temporary, in which case it is called a temporary threshold shift (TTS). Still lower exposures may result in auditory masking (described in Subchapter 5.2.4), which may interfere with an animal’s ability to hear other concurrent sounds.

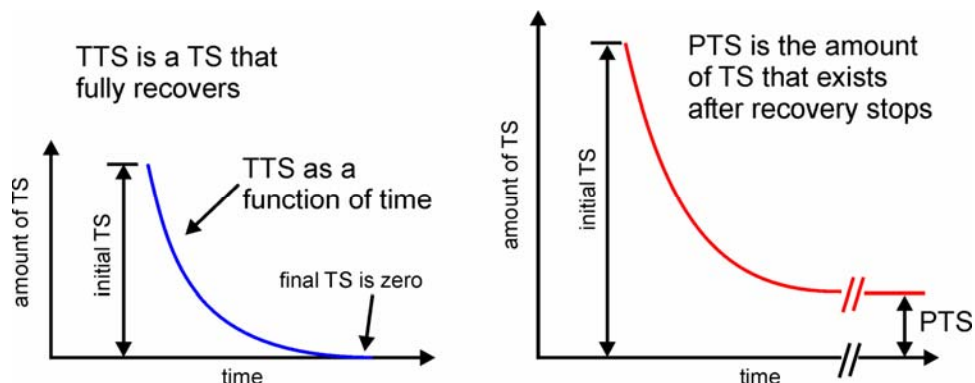
Because the tissues of the ear appear to be the most susceptible to the physiological effects of sound and TSs tend to occur at lower exposures than other more serious auditory effects, PTS and TTS are used here as the biological indicators of physiological effects. The remainder of this subchapter is, therefore, focused on TSs, including PTSs and TTSs. Since masking (without a resulting TS) is not associated with abnormal physiological function, it is not considered a physiological effect in this authorization request, but rather a potential behavioral effect. Descriptions of other potential physiological effects, including acoustically mediated bubble growth and air cavity resonance, are described in the RIMPAC 2006 Supplement.

Noise-Induced Threshold Shifts

The amount of TS depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward, 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al., 1966; Ward, 1997).

The magnitude of a TS normally decreases with the amount of time post-exposure (Miller, 1974). The amount of TS just after exposure is called the initial TS. If the TS eventually returns to zero (the threshold returns to the pre-exposure value), the TS is a TTS. Since the amount of TTS depends on the time post-exposure, it is common to use a subscript to indicate the time in minutes after exposure (Quaranta et al., 1998). For example, TTS_2 means a TTS measured two minutes after exposure. If the TS does not return to zero but leaves some finite amount of TS, then that remaining TS is a PTS. The distinction between PTS and TTS is based on whether there is a complete recovery of a TS following a sound exposure. Figure 6-3 shows two hypothetical TSs: one that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

Figure 6-3 Hypothetical Temporary and Permanent Threshold Shifts



PTS, TTS, and Harassment Zones

PTS is non-recoverable and, by definition, must result from the destruction of tissues within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the wording of the MMPA. In the RIMPAC 2006 Supplement, the smallest amount of PTS (onset-PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset-PTS is used to define the outer limit of the Level A harassment zone.

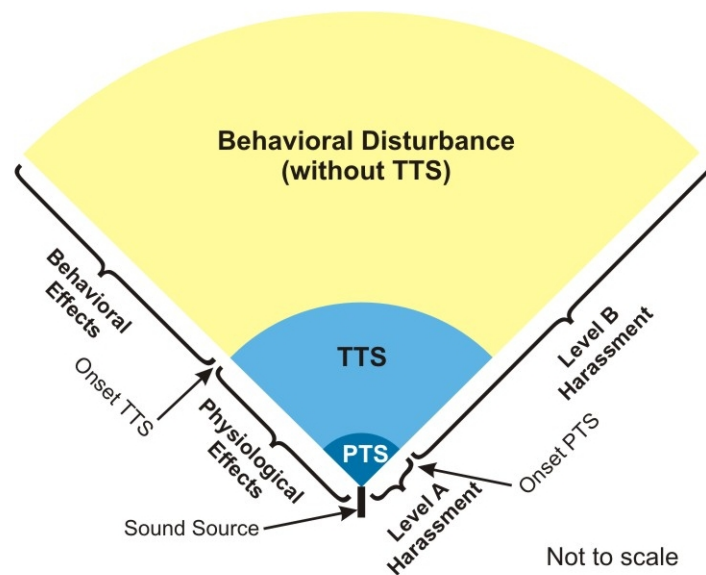
TTS is recoverable and, as in recent rulings (NOAA 2001, 2002a), is considered to result from the temporary, non-injurious distortion of hearing-related tissues. In the RIMPAC 2006 Supplement, the smallest measurable amount of TTS (onset-TTS) is taken as the best indicator

for slight temporary sensory impairment. Because it is considered non-injurious, the acoustic exposure associated with onset-TTS is used to define the outer limit of the portion of the Level B harassment zone attributable to physiological effects. This follows from the concept that hearing loss potentially affects an animal's ability to react normally to the sounds around it. Therefore, in the RIMPAC 2006 Supplement, the potential for TTS is considered as a Level B harassment that is mediated by physiological effects on the auditory system.

6.2.2.5 Summary of Regulatory and Biological Framework

Figure 6-4 summarizes the acoustic effect framework used in this authorization request. (This figure is intended to illustrate the general relationships between harassment zones and does not represent the sizes or shapes of the actual harassment zones.) Potential effects are categorized as either physiological effects, which include PTS and TTS, or behavioral effects. Categorizing potential effects as either physiological or behavioral effects allows them to be related to the harassment definitions.

Figure 6-4 Summary of the Acoustic Effect Framework Used in This Authorization Request



(This figure is intended to illustrate the general relationships between harassment zones and does not represent the sizes or shapes of the actual harassment zones)

The volumes of ocean in which Level A and Level B harassment is predicted to occur are described as harassment zones. The Level A harassment zone extends from the source out to the distance and exposure where onset-PTS is predicted to occur. The Level B harassment zone begins just beyond the point of onset-PTS and extends outward to the distance and exposure where no (biologically significant) behavioral disruption is expected to occur. The Level B harassment zone includes both behavioral effects and physiological effects, and includes the region in which TTS is predicted to occur. Criteria and thresholds used to define the outer limits of the Level A and Level B harassment zones are given in Subchapters 6.2.3 and 6.2.4.

6.2.3 Criteria and Thresholds for Physiological Effects

This subchapter presents the effect criteria and thresholds for physiological effects of sound leading to injury and behavioral disturbance. Subchapter 6.2.2 identified the tissues of the ear as being the most susceptible to physiological effects of underwater sound. PTS and TTS were determined to be the most appropriate biological indicators of physiological effects that equate to the onset of injury (Level A harassment) and behavioral disturbance (Level B harassment), respectively. This subchapter is, therefore, focused on criteria and thresholds to predict PTS and TTS in marine mammals.

Marine mammal ears are functionally and structurally similar to terrestrial mammal ears; however, there are important differences (Ketten 2000). The most appropriate information from which to develop PTS/TTS criteria for marine mammals would be experimental measurements of PTS and TTS from marine mammal species of interest. TTS data exist for several marine mammal species and may be used to develop meaningful TTS criteria and thresholds. PTS data do not exist for marine mammals and are unlikely to be obtained. Therefore, PTS criteria must be developed from TTS criteria and estimates of the relationship between TTS and PTS.

This subchapter begins with a review of the existing marine mammal TTS data. The review is followed by a discussion of the relationship between TTS and PTS. The specific criteria and thresholds for TTS and PTS used in this authorization request are then presented. This is followed by discussions of sound energy flux density level (EL), the relationship between EL and sound pressure level (SPL), and the use of SPL and EL in previous environmental compliance documents.

Energy Flux Density Level and Sound Pressure Level

Energy Flux Density Level (EL) is measure of the sound energy flow per unit area expressed in dB. EL is stated in dB re $1 \mu\text{Pa}^2\text{-s}$ for underwater sound and dB re $(20 \mu\text{Pa})^2\text{-s}$ for airborne sound.

Sound Pressure Level (SPL) is a measure of the root-mean square, or “effective,” sound pressure in decibels. SPL is expressed in dB re $1 \mu\text{Pa}$ for underwater sound and dB re $20 \mu\text{Pa}$ for airborne sound.

6.2.3.1 TTS in Marine Mammals

A number of investigators have measured TTS in marine mammals. These studies measured hearing thresholds in trained marine mammals before and after exposure to intense sounds. Some of the more important data obtained from these studies are onset-TTS levels – exposure levels sufficient to cause a just-measurable amount of TTS, often defined as 6 dB of TTS (for example, Schlundt et al. 2000). The existing cetacean TTS data are summarized in the following bullets.

- **Schlundt et al. (2000)** reported the results of TTS experiments conducted with bottlenose dolphins and white whales exposed to 1-second tones. This paper also includes a reanalysis of preliminary TTS data released in a technical report by Ridgway et al.

(1997). At frequencies of 3, 10, and 20 kHz, SPLs necessary to induce measurable amounts (6 dB or more) of TTS were between 192 and 201 dB re 1 μ Pa (EL = 192 to 201 dB re 1 μ Pa²-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 μ Pa and 195 dB re 1 μ Pa²-s, respectively. The sound exposure stimuli (tones) and relatively large number of test subjects (five dolphins and two white whales) make the Schlundt et al. (2000) data the most directly relevant TTS information for the scenarios described in the 2006 Supplement to the RIMPAC PEA (DoN, 2005c).

- **Finneran et al. (2001, 2003, 2005)** described TTS experiments conducted with bottlenose dolphins exposed to 3-kHz tones with durations of 1, 2, 4, and 8 seconds. Small amounts of TTS (3 to 6 dB) were observed in one dolphin after exposure to ELs between 190 and 204 dB re 1 μ Pa²-s. These results were consistent with the data of Schlundt et al. (2000) and showed that the Schlundt et al. (2000) data were not significantly affected by the masking noise used. These results also confirmed that, for tones with different durations, the amount of TTS is best correlated with the exposure EL rather than the exposure SPL.
- **Nachtigall et al. (2003a,b)** measured TTS in a bottlenose dolphin exposed to octave-band noise centered at 7.5 kHz. Nachtigall et al. (2003a) reported TTSs of about 11 dB measured 10 to 15 minutes after exposure to 30 to 50 minutes of noise with SPL 179 dB re 1 μ Pa (EL about 213 dB re μ Pa²-s). No TTS was observed after exposure to the same noise at 165 and 171 dB re 1 μ Pa. Nachtigall et al. (2003b) reported TTSs of around 4 to 8 dB 5 minutes after exposure to 30 to 50 minutes of noise with SPL 160 dB re 1 μ Pa (EL about 193 to 195 dB re 1 μ Pa²-s). The difference in results was attributed to faster post-exposure threshold measurement – TTS may have recovered before being detected by Nachtigall et al. (2003a). These studies showed that, for long-duration exposures, lower sound pressures are required to induce TTS than are required for short-duration tones. These data also confirmed that, for the cetaceans studied, EL is the most appropriate predictor for onset-TTS.
- **Finneran et al. (2000, 2002)** conducted TTS experiments with dolphins and white whales exposed to impulsive sounds similar to those produced by distant underwater explosions and seismic waterguns. These studies showed that, for very short-duration impulsive sounds, higher sound pressures were required to induce TTS than for longer-duration tones.

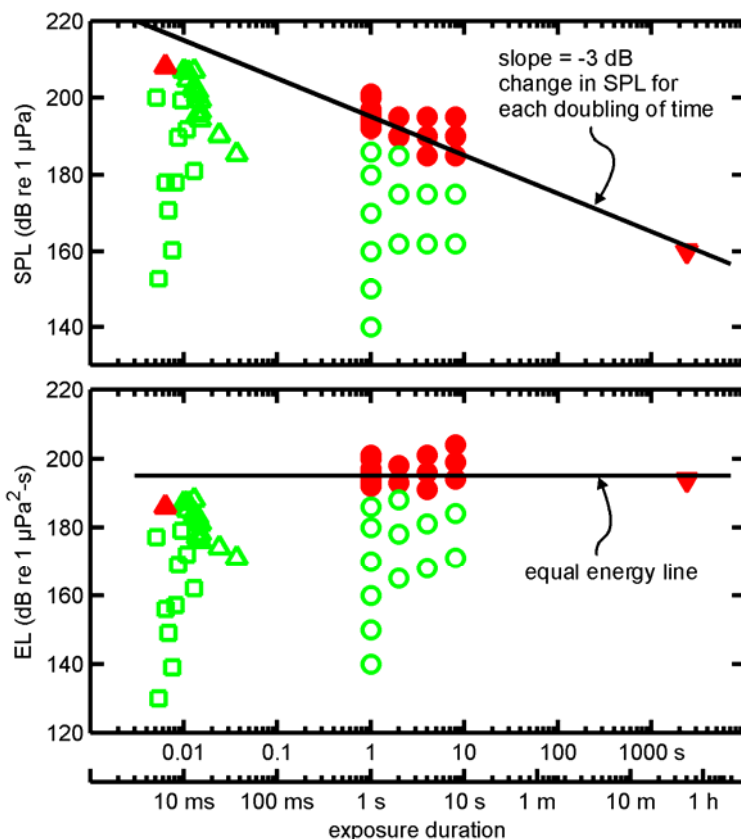
Figure 6-5 shows the existing TTS data for cetaceans (dolphins and white whales). Individual exposures are shown in terms of SPL versus exposure duration (upper panel) and EL versus exposure duration (lower panel). Exposures that produced TTS are shown as filled symbols. Exposures that did not produce TTS are represented by open symbols. The squares and triangles represent impulsive test results from Finneran et al., 2000 and 2002, respectively. The circles show the 3-, 10-, and 20-kHz data from Schlundt et al. (2000) and the results of Finneran et al. (2003). The inverted triangle represents data from Nachtigall et al. (2003b).

Figure 6-5 illustrates that the effects of the different sound exposures depend on the SPL and duration. As the duration decreases, higher SPLs are required to cause TTS. In contrast, the ELs required for TTS do not show the same type of variation with exposure duration.

The solid line in the upper panel of figure 6-5 has a slope of -3 dB per doubling of time. This line passes through the point where the SPL is 195 dB re 1 μ Pa and the exposure duration is 1

second. Since $EL = SPL + 10\log_{10}(\text{duration})$, doubling the duration *increases* the EL by 3 dB. Subtracting 3 dB from the SPL *decreases* the EL by 3 dB. The line with a slope of -3 dB per doubling of time, therefore, represents an *equal energy line* – all points on the line have the same EL, which is, in this case, 195 dB re 1 $\mu\text{Pa}^2\text{-s}$. This line appears in the lower panel as a horizontal line at 195 dB re 1 $\mu\text{Pa}^2\text{-s}$. The equal energy line at 195 dB re 1 $\mu\text{Pa}^2\text{-s}$ fits the tonal and noise data (the non-impulsive data) very well, despite differences in exposure duration, SPL, experimental methods, and subjects.

Figure 6-5 Existing TTS Data for Cetaceans



Legend:

Filled symbol:	Exposure that produced TTS
Open symbol:	Exposure that did not produce TTS
Squares:	Impulsive test results from Finneran et al., 2000
Triangles:	Impulsive test results from Finneran et al., 2002
Circles:	3, 10, and 20-kHz data from Schlundt et al. (2000) and results of Finneran et al. (2003)
Inverted triangle:	Data from Nachtigall et al., 2003b

In summary, the existing cetacean TTS data show that, for the species studied and sounds (non-impulsive) of interest, the following is true:

- **The growth and recovery of TTS are analogous to those in land mammals.** This means that, as in land mammals, cetacean TSs depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward, 1997).

For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al., 1965; Ward, 1997).

- **SPL by itself is not a good predictor of onset-TTS**, since the amount of TTS depends on both SPL and duration.
- **Exposure EL is correlated with the amount of TTS** and is a good predictor for onset-TTS for single, continuous exposures with different durations. This agrees with human TTS data presented by Ward et al. (1958, 1959).
- An energy flux density level of 195 dB re 1 $\mu\text{Pa}^2\text{-s}$ is the most appropriate predictor for onset-TTS from a single, continuous exposure.

6.2.3.2 Relationship Between TTS and PTS

Since marine mammal PTS data do not exist, onset-PTS levels for these animals must be estimated using TTS data and relationships between TTS and PTS. Much of the early human TTS work was directed towards relating TTS₂ after 8 hours of noise exposure to the amount of PTS that would exist after years of similar daily exposures (e.g., Kryter et al., 1965). Although it is now acknowledged that susceptibility to PTS cannot be reliably predicted from TTS measurements, TTS data do provide insight into the amount of TS that may be induced without a PTS. Experimental studies of the growth of TTS may also be used to relate changes in exposure level to changes in the amount of TTS induced. Onset-PTS exposure levels may therefore be predicted by:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the additional exposure, above the onset-TTS exposure, necessary to reach the maximum allowable amount of TTS that, again, may be induced without PTS. This is equivalent to estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.

Experimentally induced TTSs in marine mammals have generally been limited to around 2 to 10 dB, well below TSs that result in some PTS. Experiments with terrestrial mammals have used much larger TSs and provide more guidance on how high a TS may rise before some PTS results. Early human TTS studies reported complete recovery of TTSs as high as 50 dB after exposure to broadband noise (Ward et al., 1958, 1959, 1960). Ward et al. (1959) also reported slower recovery times when TTS₂ approached and exceeded 50 dB, suggesting that 50 dB of TTS₂ may represent a “critical” TTS. Miller et al. (1963) found PTS in cats after exposures that were only slightly longer in duration than those causing 40 dB of TTS. Kryter et al. (1966) stated: “A TTS₂ that approaches or exceeds 40 dB can be taken as a signal that danger to hearing is imminent.” These data indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS.

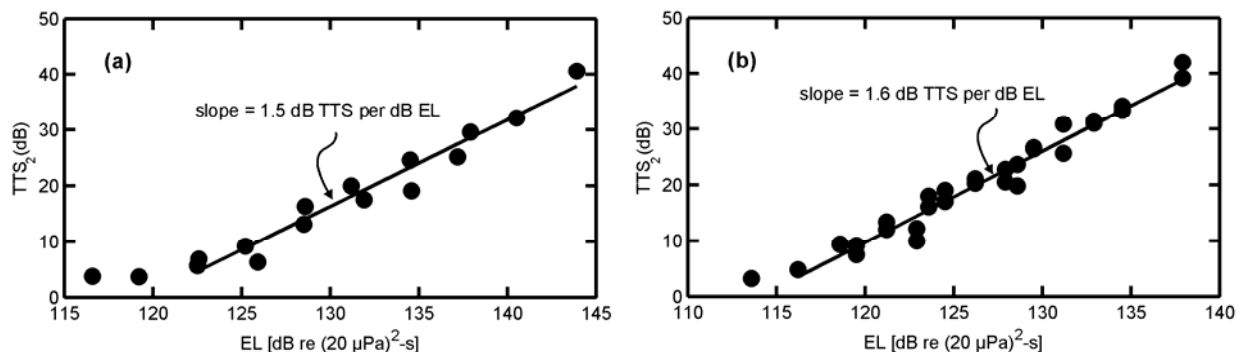
The small amounts of TTS produced in marine mammal studies also limit the applicability of these data to estimates of the growth rate of TTS. Fortunately, data do exist for the growth of TTS in terrestrial mammals. For moderate exposure durations (a few minutes to hours), TTS₂ varies with the logarithm of exposure time (Ward et al., 1958, 1959; Quaranta et al., 1998). For

shorter exposure durations the growth of TTS with exposure time appears to be less rapid (Miller, 1974; Keeler, 1976). For very long-duration exposures, increasing the exposure time may fail to produce any additional TTS, a condition known as asymptotic threshold shift (Saunders et al., 1977; Mills et al., 1979).

Ward et al. (1958, 1959) provided detailed information on the growth of TTS in humans. Ward et al. presented the amount of TTS measured after exposure to specific SPLs and durations of broadband noise. Since the relationship between EL, SPL, and duration is known, these same data could be presented in terms of the amount of TTS produced by exposures with different ELs.

Figure 6-6 shows results from Ward et al. (1958, 1959) plotted as the amount of TTS₂ versus the exposure EL. The data in figure 6-6(a) are from broadband (75 Hz to 10 kHz) noise exposures with durations of 12 to 102 minutes (Ward et al., 1958). The symbols represent mean TTS₂ for 13 individuals exposed to continuous noise. The solid line is a linear regression fit to all but the two data points at the lowest exposure EL. The experimental data are fit well by the regression line ($R^2 = 0.95$). These data are important for two reasons: (1) they confirm that the amount of TTS is correlated with the exposure EL; and (2) the slope of the line allows one to estimate the additional amount of TTS produced by an increase in exposure. For example, the slope of the line in figure 6-6(a) is approximately 1.5 dB TTS₂ per dB of EL. This means that each additional dB of EL produces 1.5 dB of additional TTS₂.

Figure 6-6 Growth of TTS Versus the Exposure EL (from Ward et al. [1958, 1959])



The data in figure 6-6(b) are from octave-band noise exposures (2.4 to 4.8 kHz) with durations of 12 to 102 minutes (Ward et al., 1959). The symbols represent mean TTS for 13 individuals exposed to continuous noise. The linear regression was fit to all but the two data points at the lowest exposure EL. The results are similar to those shown in figure 6-6(a). The slope of the regression line fit to the mean TTS data was 1.6 dB TTS₂/dB EL. A similar procedure was carried out for the remaining data from Ward et al. (1959), with comparable results. Regression lines fit to the TTS versus EL data had slopes ranging from 0.76 to 1.6 dB TTS₂/dB EL, depending on the frequencies of the sound exposure and hearing test.

An estimate of 1.6 dB TTS₂ per dB increase in exposure EL is the upper range of values from Ward et al. (1958, 1959) and gives the most conservative estimate – it predicts a larger amount of TTS from the same exposure compared to the lines with smaller slopes. The difference

between onset-TTS (6 dB) and the upper limit of TTS before PTS (40 dB) is 34 dB. To move from onset-TTS to onset-PTS, therefore, requires an increase in EL of 34 dB divided by 1.6 dB/dB, or approximately 21 dB. An estimate of 20 dB between exposures sufficient to cause onset-TTS and those capable of causing onset-PTS is a reasonable approximation.

To summarize:

- In the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated from marine mammal TTS data and PTS/TTS relationships observed in terrestrial mammals. This involves:
 - Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
 - Estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.
- A variety of terrestrial mammal data sources point toward 40 dB as a reasonable estimate of the largest amount of TS that may be induced without PTS. A conservative assumption is that continuous-type exposures producing TSs of 40 dB or more always result in some amount of PTS.
- Data from Ward et al. (1958, 1959) reveal a linear relationship between TTS_2 and exposure EL. A value of 1.6 dB TTS_2 per dB increase in EL is a conservative estimate of how much additional TTS is produced by an increase in exposure level for continuous-type sounds.
- There is a 34 dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB). The additional exposure above onset-TTS that is required to reach PTS is therefore 34 dB divided by 1.6 dB/dB, or approximately 21 dB.
- Exposures with ELs 20 dB above those producing TTS may be assumed to produce a PTS. This number is used as a conservative simplification of the 21 dB number derived above.

6.2.3.3 Threshold Levels for Harassment from Physiological Effects

For this specified action, sound exposure thresholds for TTS and PTS are as presented in the following text box:

195 dB re 1 μPa^2 -s received EL for TTS

215 dB re 1 μPa^2 -s received EL for PTS

Marine mammals predicted to receive a sound exposure with EL of 215 dB re 1 μPa^2 -s or greater are assumed to experience PTS and are counted as Level A harassment. Marine mammals predicted to receive a sound exposure with EL greater than or equal to 195 dB re 1 μPa^2 -s but less than 215 dB re 1 μPa^2 -s are assumed to experience TTS and are counted as Level B harassment. Analyses for each individual species are presented in Subchapter 6.2.7.

Derivation of Effect Thresholds

The TTS threshold is primarily based on the cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The mean exposure EL required to produce onset-TTS in these tests was 195 dB re 1 $\mu\text{Pa}^2\text{-s}$. This result is corroborated by the short-duration tone data of Finneran et al. (2000, 2003) and the long-duration noise data from Nachtigall et al. (2003a,b). Together, these data demonstrate that TTS in cetaceans is correlated with the received EL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re 1 $\mu\text{Pa}^2\text{-s}$.

The PTS threshold is based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure EL. This estimate is conservative because: (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS, and (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959).

Use of EL for Physiological Effect Thresholds

Effect thresholds are expressed in terms of total received EL. Energy flux density is a measure of the flow of sound energy through an area. Marine and terrestrial mammal data show that, for continuous-type sounds of interest, TTS and PTS are more closely related to the energy in the sound exposure than to the exposure SPL.

The EL for each individual ping is calculated from the following equation:

$$\text{EL} = \text{SPL} + 10\log_{10}(\text{duration})$$

The EL includes both the ping SPL and duration. Longer-duration pings and/or higher-SPL pings will have a higher EL.

If an animal is exposed to multiple pings, the energy flux density in each individual ping is summed to calculate the total EL. Since mammalian TS data show less effect from intermittent exposures compared to continuous exposures with the same energy (Ward, 1997), basing the effect thresholds on the total received EL is a conservative approach for treating multiple pings; in reality, some recovery will occur between pings and lessen the effect of a particular exposure. Therefore, estimates are conservative because recovery is not taken into account – intermittent exposures are considered comparable to continuous exposures.

The total EL depends on the SPL, duration, and number of pings received. The TTS and PTS thresholds do not imply any specific SPL, duration, or number of pings. The SPL and duration of each received ping are used to calculate the total EL and determine whether the received EL meets or exceeds the effect thresholds. For example, the TTS threshold would be reached through any of the following exposures:

- A single ping with SPL = 195 dB re 1 μPa and duration = 1 second.
- A single ping with SPL = 192 dB re 1 μPa and duration = 2 seconds.

- Two pings with SPL = 192 dB re 1 μ Pa and duration = 1 second.
- Two pings with SPL = 189 dB re 1 μ Pa and duration = 2 seconds.

Comparison to SURTASS LFA Risk Functions

The effect thresholds described in this authorization request should not be confused with criteria and thresholds used for the Navy's Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar. SURTASS LFA features pings lasting many tens of seconds. The sonars of concern for use during RIMPAC 2006 emit pings lasting a few seconds at most. SURTASS LFA risk functions were expressed in terms of the received "single ping equivalent" SPL. Effect thresholds in this authorization request are expressed in terms of the total received EL. The SURTASS LFA risk function parameters cannot be directly compared to the effect thresholds used in the RIMPAC 2006 Supplement. Comparisons must take into account the differences in ping duration, number of pings received, and method of accumulating effects over multiple pings.

Previous Use of EL for Physiological Effects

Energy measures have been used as a part of dual criteria for cetacean auditory effects in shock trials, which only involve impulsive-type sounds (DoN, 1997, 2001a). These actions used 192 dB re 1 μ Pa²-s as a reference point to derive a TTS threshold in terms of EL. A second TTS threshold, based on peak pressure, was also used. If either threshold was exceeded, effect was assumed.

The 192 dB re 1 μ Pa²-s reference point differs from the threshold of 195 dB re 1 μ Pa²-s used in the RIMPAC 2006 Supplement. The 192 dB re 1 μ Pa²-s value was based on the minimum observed by Ridgway et al. (1997) and Schlundt et al. (2000) during TTS measurements with bottlenose dolphins exposed to 1-second tones. At the time, no impulsive test data for marine mammals were available and the 1-second tonal data were considered to be the best available. The minimum value of the observed range of 192 to 201 dB re 1 μ Pa²-s was used to protect against misinterpretation of the sparse data set available. The 192 dB re 1 μ Pa²-s value was reduced to 182 dB re 1 μ Pa²-s to accommodate the potential effects of pressure peaks in impulsive waveforms.

The additional data now available for onset-TTS in small cetaceans confirm the original range of values and increase confidence in it (Finneran et al., 2001, 2003; Nachtigall et al., 2003a, 2003b). The RIMPAC 2006 Supplement, therefore, uses the more complete data available and the mean value of the entire Schlundt et al. (2000) data set (195 dB re 1 μ Pa²-s), instead of the minimum of 192 dB re 1 μ Pa²-s. From the standpoint of statistical sampling and prediction theory, the mean is the most appropriate predictor – the "best unbiased estimator" – of the EL at which onset-TTS should occur; predicting the number of harassments in future actions relies (in part) on using the EL at which onset-TTS will most likely occur. When that EL is applied over many pings in each of many sonar exercises, that value will provide the most accurate prediction of the actual number of harassments by onset-TTS over all of those exercises. Use of the minimum value would overestimate the number of harassments because many animals counted would not have experienced onset-TTS. Further, there is no logical limiting minimum value of the

distribution that would be obtained from continued successive testing. Continued testing and use of the minimum would produce more and more erroneous estimates.

6.2.3.4 Summary of Physiological Effects Criteria

PTS and TTS are used as the criteria for physiological effects resulting in injury (Level A harassment) and behavioral disturbance (Level B harassment), respectively. Sound exposure thresholds for TTS and PTS are 195 dB re 1 $\mu\text{Pa}^2\text{-s}$ received EL for TTS and 215 dB re 1 $\mu\text{Pa}^2\text{-s}$ received EL for PTS. The TTS threshold is primarily based on cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The PTS threshold is based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on extrapolations from terrestrial mammal data indicating that PTS occurs at 40 dB or more of TS, and that TS growth occurring at a rate of approximately 1.6 dB/dB increase in exposure EL. The application of the model results to estimate marine mammal harassment for each species is discussed in Subchapter 6.2.7.

6.2.4 Criteria and Thresholds for Behavioral Effects

Subchapter 6.2.2 categorized the potential effects of sound into physiological effects and behavioral effects. Criteria and thresholds for physiological effects are discussed in Subchapter 6.2.3. This subchapter presents the effect criterion and threshold for behavioral effects of sound leading to behavioral disturbance without accompanying physiological effects. Since TTS is used as the biological indicator for a physiological effect leading to behavioral disturbance, the behavioral effects discussed in this subchapter may be thought of as behavioral disturbance occurring at exposure levels below those causing TTS.

A large body of research on terrestrial animal and human response to airborne noise exists, but results from those studies are not readily extendible to the development of effect criteria and thresholds for marine mammals. For example, “annoyance” is one of several criteria used to define impact to humans from exposure to industrial noise sources. Comparable criteria cannot be developed for marine mammals because there is no acceptable method for determining whether a non-verbal animal is annoyed. Further, differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on 8-hour-long exposures) make extrapolation of human noise exposure standards inappropriate.

Behavioral observations of marine mammals exposed to anthropogenic sound sources exist; however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars to be used during RIMPAC. At the present time there is no consensus on how to account for behavioral effects on marine mammals exposed to continuous-type sounds (National Research Council 2003).

This application uses behavioral observations of trained cetaceans exposed to intense underwater sound under controlled circumstances to develop a criterion and threshold for behavioral effects of sound. These data are described in detail in Schlundt et al. (2000) and Finneran and Schlundt (2004). These data are the most applicable because they are based on controlled, tonal sound

exposures within the tactical sonar frequency range, and because the species studied are closely related to the majority of animals expected to be located within the RIMPAC ASW areas.

The behavioral response data are used to develop the behavioral effects threshold because of the (1) finer control over acoustic conditions; (2) greater quality and confidence in recorded sound exposures; and (3) the exposure stimuli closely match those of interest for RIMPAC. Since no comparable data exist, or are likely to be obtained, for wild animals, the relationship between the behavioral results reported by Finneran and Schlundt (2004) and wild animals is unknown. Although, experienced, trained subjects may tolerate higher sound levels than inexperienced animals, it is also possible that prior experiences and resultant expectations may have made some trained subjects less tolerant of the sound exposures. Potential differences between trained subjects and naïve/wild animals are accounted for by adopting a conservative “threshold for effect” compared to the regulatory definition of harassment (see Subchapter 6.2.4.2).

This subchapter begins by describing the behavioral observations used to develop the effect threshold. The specific criterion and threshold for behavioral effects used are then presented. The subchapter ends by addressing the likelihood for exposure of marine mammals to high-energy sound over extended periods of time (regarding the issue of potentially displacing a resident population) and the potential for auditory masking.

6.2.4.1 Behavioral Effects in Cetaceans Exposed to Sonar-Like Sounds

Researchers conducting TTS experiments with marine mammals have noted certain “behavioral alterations,” or changes from the subjects’ trained behaviors, that tended to occur as the subjects were exposed to sounds of increasing intensity. Behavioral alterations were generally attempts by the subjects to avoid the site of previous noise exposures (Schlundt et al., 2000), or attempts to avoid an exposure in progress (Kastak et al., 1999). On some occasions, subjects became aggressive or refused to further participate in the test (Schlundt et al., 2000).

Schlundt et al. (2000) and Finneran et al. (2001) reported behavioral alterations, defined as deviations from subjects’ normal trained behaviors, and the exposure levels above which they were observed during cetacean TTS experiments using 1-second tones. Finneran and Schlundt (2004) analyzed the behavioral data and provided a statistical summary relating altered behaviors to exposure levels. A summary of the 3-, 10-, and 20-kHz results from Finneran and Schlundt (2004) – the frequencies most directly relevant to RIMPAC – is provided below.

As described in Finneran and Schlundt (2004), the behavior of a subject during intense sound exposure experiments was subjectively compared to the subject’s “normal” behaviors to determine whether a subject exhibited altered behavior during a session. In this context, altered behavior means a deviation from a subject’s typical trained behaviors. The subjective assessment was only possible because behavioral observations were made with the same subjects during many baseline hearing sessions with no intense sound exposures. This allowed comparisons to be made between how a subject usually acted and how it acted during test sessions with intense sound exposures. Each exposure session was then categorized as “normal behavior” or “altered behavior.” Instances of altered behavior generally began at lower exposures than those causing TTS; however, there were many instances when

subjects exhibited no altered behavior at levels above onset-TTS levels. Regardless of reactions at higher or lower levels, all instances of altered behavior were included in the statistical summary.

Test sessions were grouped by species and exposure frequency. Within each group, the percentage of sessions in which subjects showed altered behavior was calculated as a function of exposure level.

Figure 6-7 shows the percentage of sessions with altered behavior at each EL for the 3-, 10-, and 20-kHz data. Since the tones were 1 second in duration, the SPL and EL have the same numeric values. The figure has three panels. The top panel shows the pooled results for both white whales and dolphins, while the middle and bottom panels show the white whale and dolphin data separately.

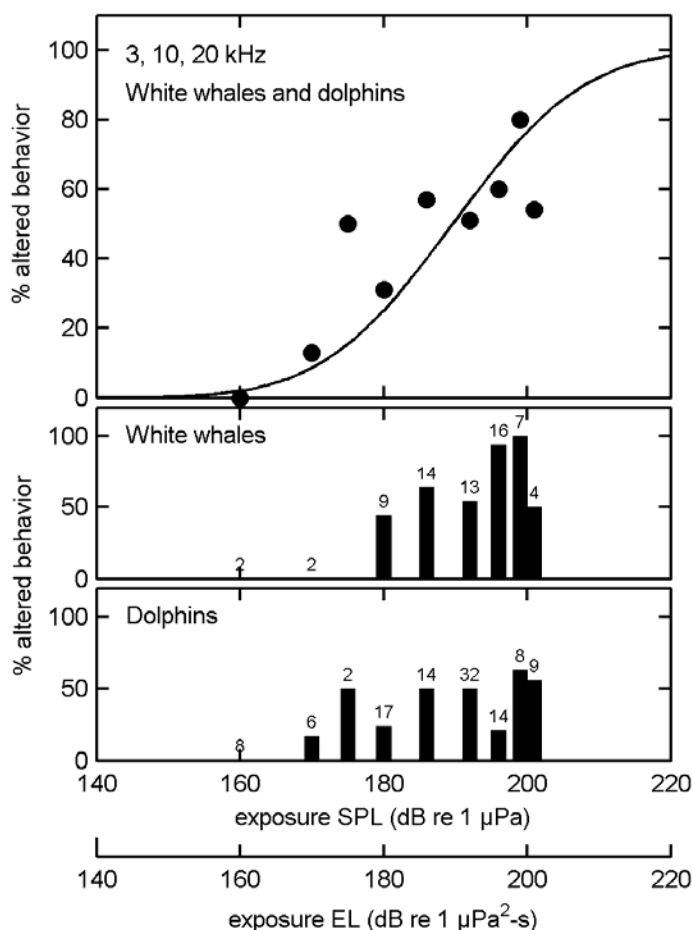
The numbers above the bars in the lower panels indicate the number of sessions at each exposure level for that species. The pooled data in the upper panel were obtained by adding the number of dolphin and white whale sessions with altered behavior and dividing the result by the total number of exposure sessions. For example, at 192 dB re 1 μ Pa exposure SPL, 7 of 13 white whale sessions and 16 of 32 dolphin sessions were categorized as altered behavior. The pooled percentage is therefore 51%, or 23 of 45 total sessions.

A probit analysis technique (Finney, 1971) was used to fit a smooth dose-response curve to the percent altered behavior versus exposure level data for the pooled dolphin/white whale data set (upper panel). The exposure levels corresponding to specific percentages of sessions with altered behavior were found by interpolating within the dose-response curve. Exposure levels corresponding to sessions with 25, 50, and 75% altered behavior were 180, 190, and 199 dB re 1 μ Pa SPL (or 180, 190, and 199 dB re 1 μ Pa²-s EL), respectively. More detailed statistical results are provided in Finneran and Schlundt (2004).

To summarize:

- Behaviors of subjects during intense sound exposures were compared to subjects' normal behaviors without intense sound exposures.
- Each test session was subjectively classified as "normal" or "altered" behavior.
- The percentage of sessions with altered behavior was calculated as a function of exposure level. The percentage of sessions with altered behavior generally increased with increasing exposure level.
- A smooth dose-response curve was fit to the resulting data.
- The exposure levels required to produce 25, 50, and 75% behavioral alteration were determined by interpolating within the dosage-response curve.
- For pooled white whale and dolphin data at 3, 10, and 20 kHz, exposure SPLs of 180, 190, and 199 dB re 1 μ Pa (ELs of 180, 190, and 199 dB re 1 μ Pa²-s) corresponded with the 25, 50, and 75% altered behavior points, respectively.

Figure 6-7 Percentage of Sessions with Altered Behavior at Each EL for the 3, 10, and 20-kHz Data



6.2.4.2 Threshold Level for Harassment from Behavioral Effects

For this specified action, based on coordination with NMFS, the threshold for behavioral response (sub-TTS) modeled in the acoustic exposure analysis for cetacea in this IHA will be based on the point at which a 25% altered behavior was observed experimentally (for tones in the 400 Hz to 75 kHz frequency range), corresponding to 173 dB re 1 $\mu\text{Pa}^2\text{-s}$ EL. This range of frequencies (400 Hz to 75 kHz) is much broader than the hull mounted mid-frequency active tactical sonar system that will be used in RIMPAC 2006.

173 dB re 1 $\mu\text{Pa}^2\text{-s}$ received EL

All marine mammals predicted to receive a sound exposure with EL greater than or equal to 173 dB re 1 $\mu\text{Pa}^2\text{-s}$ but less than 195 dB re 1 $\mu\text{Pa}^2\text{-s}$ are assumed to experience behavioral disturbance and are counted as Level B harassment. Marine mammals exposed to ELs of 195 dB re 1 $\mu\text{Pa}^2\text{-s}$ or above are assumed to experience TTS or PTS as described in Subchapter 5.2.3,

and are also counted as harassment. Analyses for each individual species are presented in Subchapter 6.2.7.

Derivation of Effect Threshold

The behavioral effects threshold is based primarily on the behavioral observations reported in Schlundt *et al.* (2000) and Finneran *et al.* (2000, 2003b, 2005). Finneran and Schlundt (2004) summarize these data and provide the statistical analysis used in development of this threshold. These studies are applicable because they used short-duration tones and frequencies similar to the sonar use modeled in this assessment. The most compelling reason for the use of this experimental data using captive animals was the considerable number of studies involved and the absence of any other data using representative sound characteristics and experimental controls.

The behavior of a subject during intense sound exposure experiments was subjectively compared to the subject's "normal" behaviors to determine whether a subject exhibited altered behavior during a session. In this context, altered behavior means a deviation from a subject's typical trained behaviors. The subjective assessment was only possible because behavioral observations were made with the same subjects during many baseline hearing sessions with no intense sound exposures. This allowed comparisons to be made between how a subject usually acted and how it acted during test sessions with intense sound exposures. Each exposure session was then categorized as "normal behavior" or "altered behavior." The behavioral alterations primarily consisted of reluctance on the part of the subjects, during a test session, to return to the site of a previous intense sound exposure. All instances of altered behavior were included in the statistical summary. An example of the results is as follows: At 192 dB re 1 μ Pa exposure SPL, 7 of 13 white whale sessions and 16 of 32 dolphin sessions were categorized as altered behavior. The pooled percentage is therefore 51%, or 23 of 45 total sessions.

Exposure levels corresponding to sessions with 25, 50, and 75% altered behavior were 180, 190, and 199 dB re 1 μ Pa SPL (or 180, 190, and 199 dB re 1 μ Pa²-s EL), respectively. More detailed statistical results are provided in Finneran and Schlundt (2004).

The use of the 50% point to estimate a single numeric "all-or-nothing" threshold from a psychometric function is a common and accepted psychophysical technique (e.g., Nachtigall, 2000; Yost, 1994). The 50% altered point from these data is a conservative approach to predicting Level B harassment because it actually represents the sensory threshold point where the sound was strong enough to potentially result in altered behavior 50% of the time; however, it may not result in significantly altered behavior as is required to be considered Level B harassment as defined for military readiness activities. Furthermore, Level B harassment for military readiness activities is defined as any act that disturbs or is likely to disturb a marine mammal indicating either a certainty of occurrence or that an occurrence is likely. It can be argued that phenomena with occurrences below 50% are "not likely" since in the majority of the times, they by definition will not occur.

Despite the rationale detailed in the preceding paragraphs and based on coordination with NMFS, the Navy has been required to use a threshold for behavioral response, (sub-TTS) modeled in the acoustic exposure analysis based on the point at which a 25% altered behavior was observed experimentally (for tones in the 400 Hz to 75 kHz frequency range), corresponding

1 to 173 dB re 1 $\mu\text{Pa}^2\text{-s}$ EL. This range of frequencies (400 Hz to 75 kHz) is much broader than the
2 hull mounted mid-frequency active tactical sonar system that will be used in RIMPAC 2006.

3
4 The use of the 173 dB re 1 $\mu\text{Pa}^2\text{-s}$ EL metric (a sub-TTS behavioral threshold) was required by
5 NMFS as a precautionary measure given there are unique circumstances present in this first
6 attempt to quantitatively predict the potential effects of sonar on marine mammals. These unique
7 factors are: (1) the first instance of application of the quantitative modeling approach, (2) the
8 animals affected are wild animals vice animals in captivity as was the case in the study used to
9 establish the behavioral threshold (Finneran and Schlundt 2004). The selection of this threshold
10 has no precedent and its use in this document is not intended to serve as precedent for any future
11 Navy “take” authorization request. Establishment of an appropriate threshold for analysis will
12 continue to be coordinated between NMFS and the Navy for future actions undertaken pursuant
13 to the Navy’s determination that a take authorization is required under the MMPA for any future
14 proposed activity.

15 16 **Use of EL for Behavioral Exposures**

17 The behavioral exposure threshold is stated in terms of EL. If an animal is exposed to multiple
18 pings, the energy flux density in each individual ping is summed to calculate the total EL. EL is
19 used for three reasons:

- 20
21 • **EL takes both the exposure SPL and duration into account.** Both SPL and duration
22 of exposure affect behavioral responses to sound, so a behavioral effect threshold must
23 include exposure duration. Use of SPL by itself in other effect scenarios relied on a
24 known or fixed exposure duration (for example, SURTASS LFA or seismic surveys). In
25 the proposed ASW training events, the behavioral effect thresholds include duration as
26 well as SPL.
- 27 • **EL takes into account the effects of multiple pings.** Exposure thresholds based on SPL
28 predict the same effect regardless of the number of received sounds. Previous actions
29 using SPL-based criteria included implicit methods to account for multiple pings, such as
30 the single-ping equivalent used in SURTASS LFA (DoN, 2001b). The use of EL for this
31 specified activity takes into account the effects of multiple pings, and does so in a
32 conservative manner, since all the energy in received pings is summed up with no benefit
33 allowed for recovery between pings.
- 34 • **EL allows a rational ordering of behavioral effects with physiological effects.** The
35 exposure thresholds for physiological effects are stated in terms of EL because
36 experimental data show that the observed effects (TTS and PTS) are correlated best with
37 the sound energy, not the SPL. Using EL for behavioral effects allows the behavioral and
38 physiological effects to be placed on a single exposure scale, with behavioral effects
39 occurring at lower exposures than physiological effects. If physiological thresholds were
40 given in EL and behavioral effects in terms of SPL, it might be possible for distances
41 associated with physiological effects to be greater than those associated with behavioral
42 effects, which violates the assumptions of the biological framework outlined in
43 Subchapter 6.2.2.

6.2.4.3 Likelihood of Prolonged Exposure

The proposed ASW activities during RIMPAC would not result in prolonged exposure because the vessels are constantly moving, and the flow of the activity in the Hawaiian Islands Operating Area when ASW training occurs reduces the potential for prolonged exposure. The implementation of the protective measures described in Chapter 11 would further reduce the likelihood of any prolonged exposure.

6.2.4.4 Likelihood of Masking

Natural and artificial sounds can disrupt behavior by masking, or interfering with an animal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by a second sound at similar frequencies and at similar or higher levels. If the second sound were artificial, it could be potentially harassing if it disrupted hearing-related behavior such as communications or echolocation. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure.

Historically, principal masking concerns have been with prevailing background noise levels from natural and manmade sources (for example, Richardson et al., 1995). Dominant examples of the latter are the accumulated noise from merchant ships and noise of seismic surveys. Both cover a wide frequency band and are long in duration.

The proposed RIMPAC ASW areas are away from harbors or heavily traveled shipping lanes. The loudest mid-frequency underwater sounds in the Proposed Action area are those produced by hull mounted mid-frequency active tactical sonar. The sonar signals are likely within the audible range of most cetaceans, but are very limited in the temporal and frequency domains. In particular, the pulse lengths are short, the duty cycle low, the total number of hours of operation per year small, and these hull mounted mid-frequency active tactical sonars transmit within a narrow band of frequencies (typically less than one-third octave).

For the reasons outlined above, the chance of sonar operations causing masking effects is considered negligible.

6.2.4.5 Summary of Behavioral Effects Criteria

For this specified activity, the sound exposure threshold for behavioral effects to estimate Level B harassment, without accompanying physiological effects, is 173 dB re 1 $\mu\text{Pa}^2\text{-s}$ received EL. The behavioral effect threshold is based on behavioral observations of trained cetaceans exposed to intense underwater sound under controlled circumstances. These data are the most applicable because they are based on controlled, tonal sound exposures within the proposed tactical sonar frequency range, and because the species studied are closely related to the majority of animals expected to be located within the RIMPAC ASW areas. The exposure threshold is a precautionary approach for predicting Level B harassment as defined in the MMPA. The threshold level is expressed in terms of EL to account for the duration of the exposure and the number of received pings, and to provide a consistent framework with the physiological effects thresholds, which are also expressed in terms of EL.

6.2.5 Application of Exposure Thresholds to Other Species

6.2.5.1 Mysticetes and Odontocetes

Information on auditory function in mysticetes is extremely lacking. Sensitivity to low-frequency sound by baleen whales has been inferred from observed vocalization frequencies, observed reactions to playback of sounds, and anatomical analyses of the auditory system. Baleen whales are estimated to hear from 15 Hz to 20 kHz, with good sensitivity from 20 Hz to 2 kHz (Ketten, 1998). Filter-bank models of the humpback whale's ear have been developed from anatomical features of the humpback's ear and optimization techniques (Houser et al., 2001). The results suggest that humpbacks are sensitive to frequencies between 40 Hz and 16 kHz, but best sensitivity is likely to occur between 100 Hz and 8 kHz. However, absolute sensitivity has not been modeled for any baleen whale species. Furthermore, there is no indication of what sorts of sound exposure produce threshold shifts in these animals.

The criteria and thresholds for PTS and TTS developed for odontocetes for this activity are also used for mysticetes. This generalization is based on the assumption that the empirical data at hand are representative of both groups until data collection on mysticete species shows otherwise. For the frequencies of interest for this action, there is no evidence that the total amount of energy required to induce onset-TTS and onset-PTS in mysticetes is different than that required for odontocetes.

6.2.5.2 Beaked Whales

Recent beaked whale strandings have prompted inquiry into the relationship between mid-frequency active sonar and the cause of those strandings. Several suggested causes of those strandings are described in Subchapter 6.2.6. In the one stranding where U.S. Navy mid-frequency active sonar has been identified as the most plausible contributory source to the stranding event (in the Bahamas in 2000), the Navy participated in an extensive investigation of the stranding with NMFS (DoC and DoN 2001). The specific mechanisms that led to the Bahamas stranding are not understood and there is uncertainty regarding the ordering of effects that led to the stranding. It is uncertain as to whether beaked whales were directly injured by sound (a physiological effect) prior to stranding or whether a behavioral response to sound occurred that ultimately caused the beaked whales to strand and be injured.

The "Joint Interim Report, Bahamas Marine Mammal Stranding Event of 15-16 March 2000" (DoC and DoN 2001) concluded that environmental and biological factors, including (1) intensive use of multiple sonar units; (2) whale presence, especially beaked whale species; (3) surface duct presence; (4) high relief bathymetry such as seamounts and canyons; and (5) a constricted channel with limited egress (approximately 19 nm wide by 100 nm long) were contributory factors to the Bahamas stranding.

During the RIMPAC exercise there will be intensive use of multiple sonar units and three beaked whale species that may be present in the same vicinity. A surface duct may be present in a limited area for a limited period of time. Most of the ASW training events take place in the deep ocean well removed from areas of high bathymetric relief. Although some of the training events will take place in such areas, none of the training events will take place in a location having a constricted channel with limited egress similar to the Bahamas. Consequently, the confluence of

factors believed to contribute to the Bahamas stranding are not present in the Hawaiian Islands and will therefore not be present during RIMPAC.

Separate and meaningful effects thresholds cannot be developed specifically for beaked whales because the exact causes of beaked whale strandings are currently unknown. However, since use of mid-frequency active tactical sonar is required for RIMPAC training events, this IHA authorization request takes a precautionary approach and treats all predicted behavioral disturbance of beaked whales as potential non-lethal injury. All predicted Level B harassment of beaked whales is therefore treated as non-lethal Level A harassment. Based on decades of ASW training having occurred in the Hawaiian Islands, including 19 previous RIMPAC exercises, and no evidence of any beaked whale strandings having occurred in the timeframe of those events or otherwise associated with any of those events, it is extremely unlikely that any significant behavioral response will result from the interaction of beaked whales and the use of sonar during the RIMPAC exercise.

6.2.6 Other Effects Considered

Acoustically Mediated Bubble Growth

One suggested cause of injury to marine mammals is rectified diffusion (Crum and Mao, 1996), the process of increasing the size of a bubble by exposing it to a sound field. This process is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard, 1979). Deeper and longer dives of some marine mammals (for example, beaked whales) are theoretically predicted to induce greater supersaturation (Houser et al., 2001b). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness.

It is unlikely that the short duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state for a long enough period of time for bubbles to become of a problematic size. Yet another hypothesis has speculated that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al., 2003). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Collectively, these hypotheses can be referred to as “hypotheses of acoustically mediated bubble growth.”

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann, 2004; Evans and Miller, 2003). To date, ELs predicted to cause in vivo bubble

formation within diving cetaceans have not been evaluated (NOAA, 2002b). Further, although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson et al., 2003), there is no conclusive evidence of this. Because evidence supporting it is debatable, no marine mammals addressed in this RIMPAC Supplement are given special treatment due to the possibility for acoustically mediated bubble growth. Beaked whales are, however, assessed differently from other species to account for factors that may have contributed to prior beaked whale strandings as set out in the previous subchapter.

Resonance

Another suggested cause of injury in marine mammals is air cavity resonance due to sonar exposure. Resonance is a phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration – the particular frequency at which the object vibrates most readily. The size and geometry of an air cavity determine the frequency at which the cavity will resonate. Displacement of the cavity boundaries during resonance has been suggested as a cause of injury. Large displacements have the potential to tear tissues that surround the air space (for example, lung tissue).

Understanding resonant frequencies and the susceptibility of marine mammal air cavities to resonance is important in determining whether certain sonars have the potential to affect different cavities in different species. In 2002, NMFS convened a panel of government and private scientists to address this issue (NOAA, 2002b). They modeled and evaluated the likelihood that Navy mid-frequency active sonar caused resonance effects in beaked whales that eventually led to their stranding (DoC and DoN, 2001). The conclusions of that group were that resonance in air-filled structures was not likely to have caused the Bahamas stranding (NOAA, 2002b). The frequencies at which resonance was predicted to occur were below the frequencies utilized by the sonar systems employed. Furthermore, air cavity vibrations due to the resonance effect were not considered to be of sufficient amplitude to cause tissue damage. By extension, this RIMPAC Supplement assumes that similar phenomenon would not be problematic in other cetacean species.

Long-Term Effects

The locations of the RIMPAC activities would repeatedly use the same area of ocean over a period of years, so there could be effects to marine mammals that may occur as a result of repeated use over time that may become evident over longer periods of time (e.g., changes in habitat use or habituation). However, as described earlier, this RIMPAC IHA assumes that short-term non-injurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. Application of this criterion assumes an effect even though it is highly unlikely that all behavioral disruptions or instances of TTS will result in long term impacts. The Navy considers this overestimate of Level B harassment to be prudent due to the proposed use of ASW training areas within the Hawaiian Islands Operating Area. This approach is precautionary because:

- There is no established scientific correlation between mid-frequency sonar use and long-term abandonment or significant alteration of behavioral patterns in marine mammals.

- It is highly unlikely that a marine mammal (or group of animals) would experience any long-term effects because the proposed training use within the RIMPAC ASW modeling areas makes individual mammals' repeated and/or prolonged exposures to high-level sonar signals unlikely. Specifically, mid-frequency sonars have limited marine mammal exposure ranges and relatively high platform speeds.

In addition to the conservative approach for estimating Level B harassment, as an additional measure, a monitoring program will be implemented to study the potential long-term effects of repeated short-term sound exposures over time. Significant long-term changes in habitat use or behavior, if they occur, might only become evident over an extended monitoring period. Further information on the program to be implemented to monitor for these potential changes is provided in Chapter 11.

6.2.7 Acoustic Effects Analysis

6.2.7.1 Acoustic Sources

The tactical military sonars to be deployed in RIMPAC are designed to detect submarines in tactical operational scenarios. This task requires the use of the sonar MF range (1 kHz to 10 kHz) predominantly.

- The types of tactical acoustic sources that would be used in training exercises during RIMPAC are described in Subchapter 1.2.2.

In order to estimate acoustic exposures from the RIMPAC ASW operations, acoustic sources to be used were examined with regard to their operational characteristics. Systems with acoustic source levels below 205 dB re 1 μ Pa @ 1 m were not included in the analysis given that at this source level (205 dB re 1 μ Pa @ 1 m) or below, a 1-second ping would attenuate below the behavioral disturbance threshold of 173 dB at a distance of about 100 meters. As additional verification, sources at this level were examined typically using simple spreadsheet calculations to ensure that they did not need to be considered further. For example, a sonobuoys typical use yielded an exposure area that produced 0 marine mammal exposures based on the maximum animal density. Such a source was called non-problematic and was not modeled in the sense of running its parameters through the environmental model (CASS), generating an acoustic footprint, etc. The proposed counter measures source level was less than 205 dB but its operational modes were such that a simple "look" was not applicable, and a separate study was conducted to ensure it did not need to be considered further.

In addition, systems with an operating frequency greater than 100 kHz were not analyzed in the detailed modeling as these signals attenuate rapidly resulting in very short propagation distances. Acoustic countermeasures were previously examined and found not to be problematic. The AN/AQS 13 (dipping sonar) used by carrier based helicopters was determined in the *Environmental Assessment/Overseas Environmental Assessment of the SH-60R Helicopter/ALFS Test Program*, October 1999 not to be problematic due to its limited use and very short pulse length (2 to 5 pulses of 3.5 to 700 msec). Since 1999, during the time of the test program, there have been over 500 hours of operation, with no environmental effects observed. The Directional Command Activated Sonobuoy System (DICASS) sonobuoy was determined not to be

problematic having a source level at 201dB re 1 μ Pa @ 1 m. These acoustic sources, therefore, did not require further examination in this analysis.

Based on the information above, only hull mounted mid-frequency active tactical sonar was determined to have the potential to affect marine mammals protected under the MMPA and ESA during RIMPAC ASW training events.

The analysis is designed to estimate the sound exposure for marine mammals produced by each sonar training event in each of the six acoustic exposure model areas. While ASW events will occur throughout the Hawaiian Islands Operating Area, these six areas were used for analysis as being representative of the bathymetric conditions and marine mammal habitats in the entire Hawaiian Islands Operating Area.

Table 6-1 summarizes the total ASW training expected during RIMPAC.

Table 6-1 Summary of Typical RIMPAC ASW Training Events

Exercise Period	Events	Hours of ASW in Each RIMPAC Acoustic Effect Model Area						
		Total Hours	1	2	3	4	5	6
I	9	36	2	2	7	12	7	6
II	8	62	4	10	22		8	18
III	6	100		61	9		13	17
IV	6	71		39	12		16	4
V	5	85		68	15			2
VI	4	79		57	12			10
VII	2	38		14				24
VIII	2	27		3				24
IX	1	14		14				
X	1	20		20				
Total	44	532	6	288	77	12	44	105

6.2.7.2 Acoustic Environment Data

Several environmental inputs are necessary to model the acoustic propagation within the RIMPAC ASW Areas: bathymetry, wind speeds, sound speed profiles, and bottom characteristics.

Digitized Bathymetric Data Base-Variable (DBDBV) bathymetry information was obtained from PCIMAT (Personal Computer Interactive Multisensor Analysis Trainer) and used as a bottom depth table in CASS. Sound speed information was obtained from the NAVO Generalized Digital Environmental Model (GDEM 3) <https://128.160.23.42/gdemv/gdemv.html>. All sound speed profiles are for July since that is the anticipated time frame for RIMPAC 06.

Each RIMPAC ASW Area was examined to determine if there was a variation in propagation across the area focusing on bathymetric contours. Although several of the acoustic modeling areas (Area 1, Area 2, and Area 4) have some shallow water area, the shallow water area is limited and quickly deepens. Generally, the RIMPAC acoustic modeling areas are deep water sites with little variability across the area.

6.2.7.3 Acoustic Exposure Analysis Modeling

The six acoustic modeling areas surrounding the Hawaiian Islands were modeled with the Comprehensive Acoustic System Simulation Gaussian Ray Bundle (CASS/GRAB) model. CASS is an Oceanographic and Atmospheric Master Library (OAML) Navy Standard performance prediction model.

The Navy's GRAB program provides detailed multipath pressure information as a function of range, depth and bearing. It also allows input of area-dependent environmental information so that, for example, as the bottom depths and sediment types change across the area their acoustic exposures can be modeled. The source's frequency and vertical beam pattern are also inputs used.

The modeling for surface ship active tactical sonar occurred in five broad steps, listed below. Results were calculated based on the typical ASW activities planned for RIMPAC 2006. Acoustic propagation and mammal population data are analyzed for the July timeframe because RIMPAC occurs in July. Marine mammal survey data for the offshore area beyond 25 nm (Barlow 2003) and survey data for near shore areas (within 25 nm; Mobley et al. 2000) provided marine mammal species density for modeling.

Step 1. Perform a propagation analysis for the area ensonified using spherical spreading loss and the Navy's CASS/GRAB program, respectively.

Step 2. Convert the propagation data into a two-dimensional acoustic footprint for the acoustic sources engaged in each training event as they move through the six acoustic exposure model areas.

Step 3. Calculate the total energy flux density level for each ensonified area summing the accumulated energy of all received pings.

Step 4. Compare the total energy flux density to the thresholds and determine the area at or above the threshold to arrive at a predicted marine mammal effects area.

Step 5. Multiply the exposure areas by the corresponding mammal population density estimates. Sum the products to produce species sound exposure rate. Analyze this rate based on the annual number of events for each exercise scenario to produce annual acoustic exposure estimates.

Table 6-2 presents the results of the acoustic exposure modeling. The results of the model must be considered in light of additional information on the species (habitat preferences, likely activities in the area, and sighting history in relation to the proposed RIMPAC locations) to determine if the sound exposures predicted in the model are expected to occur in the RIMPAC ASW areas. This evaluation is provided below.

6.2.8 Estimated Acoustic Exposures

When analyzing the results of the acoustic exposure modeling to provide an estimate of effects, it is important to understand that there are limitations to the ecological data used in the model, and that the model results must be interpreted within the context of a given species' ecology.

Table 6-2 MMPA Level B Harassment Estimates of Marine Mammals during RIMPAC 06

MARINE MAMMAL SPECIES	RIMPAC ASW MODELING AREA All numbers are Level B harassment						TOTALS		
	1	2	3	4	5	6	TTS Total	Sub-TTS Total	TOTAL
Rough-toothed dolphin	8	1,880	381	162	329	1,098	49	3,809	3,858
Dwarf sperm whale	8	1,769	627	153	355	1,034	48	3,898	3,946
Fraser's dolphin	7	1,565	317	135	314	915	41	3,212	3,253
†Cuvier's beaked whale	5	1,193	220	103	239	697	29	2,428	2,457
Spotted dolphin	9	2,013	406	173	405	1,175	52	4,129	4,181
Striped dolphin	5	994	601	86	199	579	26	2,438	2,464
Short-finned pilot whale	6	1,432	290	124	287	836	37	2,938	2,975
Pygmy sperm whale	3	650	135	58	136	399	14	1,367	1,381
*Sperm whale	6	692	145	60	141	407	34	1,417	1,451
Bottlenose dolphin	3	562	114	48	92	329	11	1,137	1,148
Melon-headed whale	2	327	64	28	66	138	4	621	625
Spinner dolphin	6	1,303	283	121	281	819	37	2,776	2,813
Risso's dolphin	1	178	45	19	45	158	3	443	446
†Blainville's beaked whale	1	178	45	19	45	158	3	443	446
†Longman's beaked whale	0	67	14	6	14	39	0	140	140
Pygmy killer whale	0	67	14	6	14	39	0	140	140
Bryde's whale	0	47	9	4	9	27	0	96	96
Killer whale	0	47	9	4	9	27	0	96	96
*Fin whale	1	31	7	2	6	17	3	61	64
False killer whale	0	66	14	6	13	38	0	137	137
*Sei whale ¹	0	13	3	1	3	8	1	27	28
*Blue whale	0	0	0	0	0	0	0	0	0
Minke whale	0	0	0	0	0	0	0	0	0
Stenella spp.	1	201	40	17	40	116	3	412	415
Unidentified dolphin	2	305	70	30	68	201	4	672	676
†Unidentified beaked whale	0	36	7	3	6	22	0	74	74
Unidentified cetacean	0	11	1	1	2	5	0	20	20
*Monk seal ¹	0	1	0	0	0	0	1	0	1
TTS Total	2	232	53	9	31	73	400		
Sub-TTS Total	72	15,396	3,808	1,360	3,087	9,208		32,931	
Total Sub-TTS and TTS by Location	74	15,628	3,861	1,369	3,118	9,281			33,331

Notes:

* Endangered Species

† Beaked whales

¹ Calculated using percentage of fin whale Hawaiian stock. Sei is 44% of fin; Monk seal is 32% of fin.

1 When reviewing the acoustic exposure modeling results, it is also important to understand that
2 the estimates of marine mammal sound exposures are presented *without* consideration of
3 standard protective measure operating procedures or the fact there have been no confirmed
4 acoustic effects to any marine species in the previous 19 RIMPAC exercises or from any other
5 mid-frequency sonar training events within the Hawaiian Islands Operating Area. One event that
6 may involve acoustic exposures occurred in Hanalei Bay in July 2004 and is described in
7 Appendix D of the RIMPAC 2006 Supplement. The Navy will work through the MMPA
8 incidental take regulatory process to discuss the protective measures and their potential to reduce
9 the likelihood for incidental harassment of marine mammals.

10
11 The proposed RIMPAC training events only occur every other year. Since the areas would not
12 be repeatedly used during the year for RIMPAC, the potential for effects to marine mammals
13 from repetitive RIMPAC use would not be expected.

14
15 As described in Subchapters 6.2.3.1 and 6.2.4, this authorization request assumes that short-term
16 non-injurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions
17 qualify as Level B harassment. Application of this criterion assumes an effect even though it is
18 highly unlikely that all behavioral disruptions or instances of TTS will result in anything other
19 than temporary effects. This approach is overestimating because:

- 20
21 • There is no established scientific correlation between mid-frequency sonar use and long-
22 term abandonment or significant alteration of behavioral patterns in marine mammals.
- 23 • Because of the time delay between pings, and platform speed, an animal encountering the
24 sonar will accumulate energy for only a few sonar pings over the course of a few
25 minutes. Therefore, exposure to sonar would be a short term event, minimizing any
26 single animal's exposure to sound levels approaching the harassment thresholds.
- 27 • The implementation of the protective measures described in Chapter 11 would further
28 reduce the likelihood of any prolonged exposure.

29
30 The modeling for RIMPAC 2006 analyzed the potential exposures of hull mounted mid-
31 frequency hull active tactical sonar with marine mammals in the Hawaiian Islands Operating
32 Area. The modeled harassment numbers by species and location are presented in Table 6-2 and
33 indicate the potential Level B harassment exposures during RIMPAC. There is no predicted
34 Level A harassment, and so all numbers on the table represent Level B harassment. However,
35 the Level B harassment predicted for beaked whales is treated as non-lethal Level A harassment.
36 The table includes the number of estimated harassments for each species within each RIMPAC
37 ASW acoustic model area. The harassment estimates have been rounded to the nearest integer
38 since an estimated harassment ≥ 0.5 is considered one animal. Appendix C of the RIMPAC
39 2006 Supplement presents a description of the marine mammal acoustic exposure modeling
40 conducted for RIMPAC 2006.

41
42 Based on the widely dispersed RIMPAC locations, and consideration of the estimated behavioral
43 disturbance levels, each potentially affected marine mammal species was reviewed relative to
44 recruitment and survival. In all cases the conclusions are that the proposed RIMPAC ASW
45 training events would have a negligible impact on marine mammals.

As shown on the table, sperm, fin, and sei whales and monk seals are the only endangered species with modeled potential incidental harassment. In accordance with ESA requirements, the Navy has initiated formal Section 7 consultation with NMFS to address the potential that RIMPAC may affect but is not likely to adversely affect sperm, fin, and sei whales or monk seals (see Subchapter 6.2.1.7).

Table 6-2 also includes *Stenella* spp. (spotted dolphins), unidentified dolphin, unidentified beaked whale, and unidentified cetacean. This is from the density data that was input to the model. Since the density of sei whales is unknown, the ratio of sei whale Hawaiian stock to fin whale Hawaiian stock (77/174 or 44%) was used to approximate the number of sei whales exposures (fin whale exposures x 44% = number of sei whale exposures).

Although there are no density figures for blue whales, minke whales, or North Pacific right whales, given their presumed relative low abundance, it is unlikely that modeled exposures would result in harassments even if density numbers were available. Humpback whales utilize Hawaiian waters as a major breeding ground during winter and spring (November through April). Minke whales also occur seasonally in Hawaii from November through March. Based on their seasonal migrations, Humpback and minke whales should not be present during the RIMPAC exercise, which takes place in mid-summer, typically late June through July.

There are approximately 55 monk seals in the main Hawaiian Islands (DoN 2005a). Since density numbers are not available for pinnipeds, potential exposures were modeled using a ratio of the number of monk seals to the number of fin whales. Based on discussions with NOAA, only potential TTS exposures are considered for monk seals. This analysis indicates that one (1) monk seal would be exposed to sound levels above the TTS threshold. Given monk seals' relative low abundance, it is unlikely that modeled exposures would result in harassments. In addition, the majority of the sonar training events will take place in the deep ocean far offshore of the main islands. There have only been a few sightings of the Northern elephant seal in the Hawaiian Islands, and so they were not modeled given it is extremely unlikely they would be present in the main Hawaiian Islands during RIMPAC 2006.

As described in Subchapter 6.2.5.2, beaked whales are due special concern given that a stranding event in the Bahamas Islands in 2000 and a few other less documented events in other areas of the world suggest that beaked whales may be particularly susceptible to being affected by mid-frequency sonar although one recent study does not support the hypothesis that these species have a particularly high auditory sensitivity at the frequencies used in mid range sonar (Mandy, et al, 2006). Since the exact causes of the beaked whale stranding events are unknown, separate, meaningful thresholds cannot be derived specifically for beaked whales. However, since use of mid-frequency sonar is required during RIMPAC training events, based on NMFS recommendation, this IHA request takes a precautionary approach and treats all behavioral disturbance of beaked whales as a potential non-lethal injury. All predicted Level B harassment of beaked whales is therefore counted as Level A harassment.

As shown in Table 6-2, there are three species of beaked whales present in the Hawaiian Islands that were modeled as potentially being exposed to sound levels resulting in Level B harassment. Cuvier's beaked whales (n=2,457), Blainville's beaked whales (n=446), Longman's beaked whales (n=140), and 74 unidentified beaked whales had the potential to be affected. These

1 sound exposure numbers are precautionary accounted for as Level A harassment that will require
2 appropriate protective measures and monitoring. However, based on operational characteristics
3 and environmental conditions, it is not anticipated that the predicted incidental exposures of
4 beaked whales to acoustic harassment from RIMPAC sources would constitute serious injury or
5 mortality. In addition, there have been 19 previous RIMPAC Exercises and numerous other
6 ASW training events in the Hawaiian Islands Operating Area without stranding any beaked
7 whale species. Thus the Navy concludes that the proposed action would not affect annual rates
8 of recruitment or survival for beaked whales.

10 When looking at the acoustic model results presented in Table 6-2 it is important to remember
11 that although not considered in the modeling, the protective measures described in Chapter 11
12 will reduce the likelihood of potential marine mammal harassment. It is likely that Navy ships
13 will detect marine mammals in their vicinity. Navy ships always have two, although usually
14 more, personnel on watch serving as lookouts. In addition to the qualified Lookouts, the Bridge
15 Team is present that at a minimum also includes an Officer of the Deck and one Junior Officer of
16 the Deck whose responsibilities also include observing the waters in the vicinity of the ship.
17 Other observers may include crews of airborne helicopters and P-3 aircraft who also observe the
18 ocean surface for signs indicative of submarines. These aerial observers are also likely to spot
19 any marine mammals in their vicinity and report those observations to vessels engaged in the
20 training events.

22 It is the duty of the lookouts to report to the officer in charge, the presence of any object,
23 disturbance, discoloration in the water (since they may be indicative of a submarine's presence),
24 or marine mammal within sight of the vessel. At night, personnel engaged in ASW training
25 events may also employ the use of night vision goggles and infrared detectors, as appropriate,
26 that can also aid in the detection of marine mammals. Passive acoustic detection of vocalizing
27 marine mammals is also used to alert bridge lookouts to the potential presence of marine
28 mammals in the vicinity. Surface ships utilize a hydrophone that receives all sounds, such as
29 marine mammal vocalizations, and transmit the sound to speakers located on the bridge and in
30 the sonar station. When the mid-frequency sonar is not active it is in receive mode and, in this
31 passive mode, is continually monitored by the sonar operators.

33 A discussion of potential effects to each marine mammal species is included in the following
34 subchapters.

36 **6.2.8.1 Fin Whale (*Balaenoptera physalus*)**

37 The abundance estimate of fin whales in the EEZ of the Hawaiian Islands is 174 (CV = 0.77)
38 within only the offshore water habitat (density estimate of 0.0001/km², Table 3-2). The acoustic
39 effect analysis estimates that a total of 64 fin whales will be taken by non-injury Level B
40 harassment and none by Level A harassment (Table 6-2). The analysis estimates that 3 will be
41 taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 μ Pa²-s), and 61 may be
42 taken by temporary behavioral effects (EL of 173 to 195 dB re 1 μ Pa²-s).

44 It is very likely, however, that lookouts would detect a group of fin whales at the surface given
45 their large size (probability of trackline detection = 0.90; Barlow 2003), pronounced blow, and
46 mean group size of approximately three animals. It is, therefore, very unlikely that RIMPAC

ASW training events would affect fin whales. It is remotely possible that fin whales could, due to their ability to remain submerged for long periods of time, be present undetected in the vicinity of a RIMPAC ASW training event. While it is possible that they may be affected, it is not likely that fin whales would be adversely affected given no evidence suggestive of any effects by any of the previous 19 RIMPAC Exercises. The protective measures presented in Chapter 11 would further reduce the potential for acoustic effects to fin whales.

Even in the rare event that fin whales are present in the proposed RIMPAC areas, the behavioral disturbance predicted in the acoustic model would not be significant. Fin whales primarily produce low frequency calls (below 1 kHz) with source levels up to 186 dB re 1 μ Pa at 1 m, although it is possible they produce some sounds in the range of 1.5 to 28 kHz (review by Richardson et al. 1995). There are no audiograms of baleen whales, but they tend to react to anthropogenic sound below 1 kHz, suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). In the St. Lawrence estuary area, fin whales avoided vessels with small changes in travel direction, speed and dive duration, and slow approaches by boats usually caused little response (MacFarlane 1981). Fin whales continued to vocalize in the presence of boat noise (Edds and Macfarlane 1987). Even though any undetected fin whales transiting the proposed RIMPAC ASW training areas may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered.

Based on the model results, behavioral patterns, results of past RIMPAC Exercises, and the implementation of standard operating procedure protective measures, the Navy finds that the RIMPAC ASW training events are unlikely to result in harassment of fin whales. The Navy therefore concludes that the RIMPAC ASW training events may affect but will not adversely affect fin whales.

6.2.8.2 Sei Whale (*Balaenoptera borealis*)

The abundance estimate of sei whales in the EEZ of the Hawaiian Islands is 77 (CV = 1.06) within the offshore water habitat (density estimate of 0.0000/km², Table 3-2). The acoustic effect analysis estimates that a total of 28 sei whales will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that one will be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 μ Pa²-s), and 27 may be taken by temporary behavioral effects (EL of 173 to 195 dB re 1 μ Pa²-s).

It is very likely, however, that lookouts would detect a group of sei whales at the surface given their large size (probability of trackline detection = 0.90; Barlow 2003), pronounced blow, and mean group size of approximately three animals. It is, therefore, very unlikely that RIMPAC ASW training events would affect sei whales. It is remotely possible that sei whales could, due to their ability to remain submerged for long periods of time, be present and undetected in the vicinity of a RIMPAC ASW training event. While it is possible that they may be affected, it is not likely that sei whales would be adversely affected given no evidence suggestive of any effects by any of the previous 19 RIMPAC Exercises. The protective measures presented in Chapter 11 would further reduce the potential for acoustic effects to sei whales.

Even in the rare event that sei whales are present in the proposed RIMPAC areas, the behavioral disturbance predicted in the acoustic model would not be significant. There is little information on the acoustic abilities of sei whales or their response to human activities. The only recorded sounds of sei whales are frequency modulated sweeps in the range of 1.5 to 3.5 kHz (Thompson et al. 1979; Knowlton et al. 1991) but it is likely that they also vocalized at frequencies below 1 kHz as do fin whales. There are no audiograms of baleen whales but they tend to react to anthropogenic noise below 1 kHz suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). Sei whales were more difficult to approach than were fin whales and moved away from boats but were less responsive when feeding (Gunther 1949). Even though any undetected sei whales transiting the proposed RIMPAC ASW training areas may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered.

Based on the model results, behavioral patterns, results of past RIMPAC Exercises, and the implementation of standard operating procedure protective measures, the Navy finds that the RIMPAC ASW training events are unlikely to result in harassment of sei whales. The Navy therefore concludes that the RIMPAC ASW training events may affect but will not adversely affect sei whales.

6.2.8.3 Sperm Whales (*Physeter macrocephalus*)

The acoustic modeling results predict that RIMPAC training events could result in the harassment by behavioral disruption of up to 1,451 sperm whales per RIMPAC. It is very likely, however, that lookouts would detect a group of sperm whales at the surface given their large size (probability of trackline detection = 0.87; Barlow 2003), pronounced blow, and mean group size of approximately 8 animals. It is, therefore, very unlikely that RIMPAC ASW training events would affect sperm whales. It is remotely possible that sperm whales could, due to their ability to remain submerged for long periods of time, be present undetected in the vicinity of a RIMPAC ASW training event. While it is possible that they may be affected, it is not likely that sperm whales would be adversely affected given no evidence suggestive of any effects by any of the previous 19 RIMPAC Exercises. The protective measures presented in Chapter 11 would further reduce the potential for acoustic effects to sperm whales to a level such that they are unlikely to occur.

Even in the event that sperm whales are present in the vicinity of a RIMPAC ASW event and remain undetected, the behavioral disturbance predicted in the acoustic model would not be significant. While Watkins *et al.* (1985) observed that sperm whales exposed to 3.25 kHz to 8.4 kHz pulses interrupted their activities and left the area, other studies indicate that, after an initial disturbance, the animals return to their previous activity. During playback experiments off the Canary Islands, André *et al.* (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions. When resting at the surface in a compact group, sperm whales initially reacted strongly, then ignored the signal completely (André *et al.*, 1997). Even though any undetected sperm whales transiting the proposed RIMPAC ASW training areas may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns are abandoned or significantly altered, and therefore the potential effects would be insignificant.

Based on the model results, behavioral patterns, results of past RIMPAC Exercises, and the implementation of standard operating procedure protective measures, the Navy finds that the RIMPAC ASW training events are unlikely to result in harassment of sperm whales. The Navy therefore concludes that the RIMPAC ASW training events may affect but will not adversely affect sperm whales.

6.2.8.4 Rough Toothed Dolphin (*Steno bredanensis*)

The abundance estimate of rough-toothed dolphins in the EEZ of the Hawaiian Islands is 19,904 (CV = 0.52) with the offshore waters their primary habitat (density estimate of 0.0081/km², Table 3-2). The acoustic effect analysis estimates that up to 3,858 rough-toothed dolphins will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that up to 49 may be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 μ Pa²-s) and up to 3,809 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 μ Pa²-s).

The vocalizations of rough-toothed dolphins are in the range of 4 to 7 kHz and echolocation type clicks in the range of 0.1 to 200 kHz (Miyazaki and Perrin 1994, Richardson et al. 1995), but there is no reported audiogram although their full range of hearing may extend down to 1 kHz or below as reported for other small odontocetes (Richardson et al. 1995, Nedwell et al. 2004). Active Navy sonars work in the range of 2.6 and 3.3 kHz, just below the range of sounds reported for rough-toothed dolphin and at the lower end of the audiograms for odontocetes. Active sonars may temporarily mask some sounds in the lower range of rough toothed dolphin hearing and may also cause a temporary behavioral response (i.e., diving or swimming away from the sound source). There is no information on the response of rough-tooth dolphins exposed to anthropogenic sounds, but bottlenose dolphins exposed to mid-frequency sonar sounds in a laboratory setting had an increase in heart rate (Miksis et al. 2001) and a change in their trained behaviors such as moving away from or not returning to the sound source station (Schlundt et al. 2000, Finneran et al. 2005).

Sonar operations will only cause temporary non-injury physiological or behavioral effects to rough-toothed dolphins and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to rough-tooth dolphins.

6.2.8.5 Dwarf Sperm Whale (*Kogia sima*)

The abundance estimate of dwarf sperm whales in the EEZ of the Hawaiian Islands is 19,172 (CV = 0.66) with the offshore waters their primary habitat (density estimate of 0.0078/km², Table 3-2). The acoustic effect analysis estimates that 3,946 dwarf sperm whales will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that 48 may be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 μ Pa²-s) and 3,898 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 μ Pa²-s).

Little information is available on the acoustic abilities of dwarf sperm whales, but pygmy sperm whales produce sounds in the range of 60 to 200 kHz (Richardson et al. 1995) and may also produce some sounds in the range of 1.3 to 15 kHz (Thomas 1990). Dwarf sperm whales dive

for an average of 8.6 minutes and can stay submerged for up to 43 minutes and are assumed to be deep divers (Breese and Tershy 1993, Baird 1998). Dwarf sperm whales in the Gulf of Mexico tended to orient away from survey boats or usually dove in the presence of low flying aircraft (Richardson et al. 1995). Dwarf sperm whales will likely dive and move away from the active sonar ship.

Sonar operations will only cause temporary non-injury physiological or behavioral effects to dwarf sperm whales and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to dwarf sperm whales.

6.2.8.6 Fraser's Dolphin (*Lagenodelphis hosei*)

The abundance estimate of Fraser's dolphins in the EEZ of the Hawaiian Islands is 16,836 (CV = 1.11) with the offshore waters their primary habitat (density estimate of 0.0069/km², Table 3-2). The acoustic effect analysis estimates that a total of 3,253 Fraser's dolphins will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that 41 may be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 μ Pa²-s) and 3,212 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 μ Pa²-s).

Fraser's dolphins produce sounds in the range of 7.6 to 13.4 kHz (Leatherwood et al. 1993). Navy active sonars work in the range of 2.6 and 3.3 kHz, just below the range of sounds reported for Fraser's dolphin, although their full range of hearing may extend down to 1 kHz or below as reported for other small odonticetes (Richardson et al. 1995, Nedwell et al. 2004). Active sonars may temporarily mask some sounds in the lower range of Fraser's dolphin hearing and may also cause a behavioral response. There is no information on the response of Fraser's dolphins exposed to anthropogenic sounds but bottlenose dolphins exposed to mid-frequency sonar sounds in a laboratory setting had an increase in heart rate (Miksis et al. 2001) and a change in their trained behaviors such as moving away from or not returning to the sound source station (Schlundt et al. 2000, Finneran et al. 2005). Fraser's dolphins will likely dive and move away from the active sonar ship.

Sonar operations will only cause temporary non-injury physiological or behavioral effects to Fraser's dolphins and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to Fraser's dolphins.

6.2.8.7 Cuvier's Beaked Whale (*Ziphius cavirostris*)

The abundance estimate of Cuvier's beaked whales in the EEZ of the Hawaiian Islands is 12,728 (CV = 0.83) with the offshore waters their primary habitat (density estimate of 0.0069/km², Table 3-2). The acoustic effect analysis estimates that a total of 2,457 Cuvier's beaked whales will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that 29 may be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 μ Pa²-s) and 2,428 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 μ Pa²-s). However, the Level B harassment predicted for beaked whales is treated as non-lethal Level A harassment.

There is no information on the response of Cuvier's beaked whale exposed to anthropogenic sounds or on their acoustic abilities but other Ziphiid species have vocalizations in the range of <1.0 to 16 kHz (Richardson et al. 1995). Preliminary data on their diving behavior showed a range of dives from 19 to 87 minutes (Baird et al. 2004). Like many other species of odonticetes, Cuvier's beaked whales will likely dive and move away from the active sonar ship.

Sonar operations will only cause temporary non-injury physiological or behavioral effects to Cuvier's beaked whales and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to Cuvier's beaked whales.

6.2.8.8 Pantropical Spotted Dolphin (*Stenella attenuata*)

The abundance estimate of pantropical spotted dolphins in the EEZ of the Hawaiian Islands is 10,260 (CV = 0.41) with the inshore waters their primary habitat (density estimate of 0.0407/km², Table 3-2). The acoustic effect analysis estimates that a total of 4,181 pantropical spotted dolphins will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that 52 may be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 µPa²-s) and 4,129 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 µPa²-s).

There is little information on the acoustic abilities of the pantropical spotted dolphin. They produce whistles in the range of 3.1 to 21.4 kHz with the dominant frequency being 6.7 to 17.8 kHz, above that of the active sonar frequencies. Although their full range of hearing may extend down to 1 kHz or below as reported for other small odonticetes (Richardson et al. 1995, Nedwell et al. 2004). Active sonars may temporarily mask some sounds in the lower range of pantropical spotted dolphin hearing and may also cause a behavioral response. There is no information on the response of pantropical spotted dolphins exposed to anthropogenic sounds but bottlenose dolphins exposed to mid-frequency sonar sounds in a laboratory setting had an increase in heart rate (Miksis et al. 2001) and a change in their trained behaviors such as moving away from or not returning to the sound source station (Schlundt et al. 2000, Finneran et al. 2005).

Sonar operations will only cause temporary non-injury physiological or behavioral effects to pantropical spotted dolphins and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to pantropical spotted dolphins.

6.2.8.9 Striped Dolphin (*Stenella coeruleoalba*)

The abundance estimate of striped dolphins in the EEZ of the Hawaiian Islands is 10,385 (CV = 0.48) with the offshore waters their primary habitat (density estimate of 0.0042/km², Table 3-2). The acoustic effect analysis estimates that a total of 2,464 striped dolphins will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that 26 may be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 µPa²-s) and 2,438 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 µPa²-s). Striped dolphins produce whistles in the range of 6 to 24 kHz with the dominant frequency being 8 to 12.5 kHz, above that of the active sonar frequencies. Audiograms of striped dolphins show

a range of hearing from 0.5 to 160 kHz with maximum sensitivity between 29 and 123 kHz (Kastelein et al. 2003). Active sonars may temporarily mask some sounds in the lower range of Fraser's dolphin hearing and may also cause a behavioral response. There is no information on the response of striped dolphins exposed to anthropogenic sounds but bottlenose dolphins exposed to mid-frequency sonar sounds in a laboratory setting had an increase in heart rate (Miksis et al. 2001) and a change in their trained behaviors such as moving away from or not returning to the sound source station (Schlundt et al. 2000, Finneran et al. 2005).

Sonar operations will only cause temporary non-injury physiological or behavioral effects to striped dolphins and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to striped dolphins.

6.2.8.10 Short-Finned Pilot Whale (*Globicephala macrorhynchus*)

The abundance estimate of short-finned pilot whales in the EEZ of the Hawaiian Islands is 8,846 (CV = 0.49) with the inshore waters their primary habitat (density estimate of 0.0237/km², Table 3-2). The acoustic effect analysis estimates that a total of 2,975 short-finned pilot whales will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that 37 may be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 µPa²-s) and 2,938 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 µPa²-s).

There is little information on the acoustic abilities of short finned whales, but they produce whistles in the range of 0.5 to at least 20 kHz with the dominant frequencies at 2 to 14 kHz (Richardson et al. 1995). There is no information on the echolocation frequencies of short finned pilot whales, but long finned pilot whales produce echolocation clicks in the range of 6 to 11 kHz (Au 1993). Whalers around the waters of the Faroe Islands use boat echo-sounders (15 to 200 kHz) to drive long finned pilot whales in to the shore (Bloch 1991). Like many other species of odontocetes, long finned pilot whales will likely dive and move away from the active sonar ship. There is no diving behavior data on short finned pilot whales but preliminary data on several dives of two long finned pilot whales showed dives of 74 to 684 m and for 2.1 to 12.7 minutes (Baird et al. 2002).

Sonar operations will only cause temporary non-injury physiological or behavioral effects to short-finned pilot whales and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to short-finned pilot whales.

6.2.8.11 Pygmy Sperm Whale (*Kogia breviceps*)

The abundance estimate of pygmy sperm whales in the EEZ of the Hawaiian Islands is 817 (CV = 1.12) with the offshore waters their primary habitat (density estimate of 0.0030/km², Table 3-2). The acoustic effect analysis estimates that a total of 1,381 pygmy sperm whales will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that 14 may be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 µPa²-s) and 1,367 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 µPa²-s).

1 There is no information on the response of pygmy sperm whales exposed to anthropogenic
2 sounds. Pygmy sperm whales produce sounds in the range of 60 to 200 kHz (Richardson et al.
3 1995) but may also produce some sounds in the range of 1.3 to 15 kHz (Thomas 1990), and their
4 best hearing is in the range of 90 to 150 kHz (Ridgway and Carder 2001). Pygmy sperm whales
5 dive for an average of 8.6 minutes and can stay submerged for up to 43 minutes (Breese and
6 Tershy 1993, Baird 1998). Pygmy sperm whales produce clicks in the range of 60 to 200 kHz
7 (Richardson et al. 1995). Pygmy sperm whales in the Gulf of Mexico tended to orient away
8 from survey boats or usually dove in the presence of low flying aircraft (Richardson et al. 1995).
9 Most likely pygmy sperm whales will dive and move away from ships using active sonar.

10
11 Sonar operations will only cause temporary non-injury physiological or behavioral effects to
12 pygmy sperm whales and will have negligible impact on annual survival, recruitment and birth
13 rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects
14 to pygmy sperm whales.

15 **6.2.8.12 Bottlenose Dolphin (*Tursiops truncatus*)**

16 The abundance estimate of bottlenose dolphins in the EEZ of the Hawaiian Islands is 3,263 (CV
17 = 0.60) with the inshore waters their primary habitat (density estimate of 0.0103/km², Table 3-2).
18 The acoustic effect analysis estimates that a total of 1,148 bottlenose dolphins will be taken by
19 non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis
20 estimates that 11 may be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re
21 1 $\mu\text{Pa}^2\text{-s}$) and 1,137 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1
22 $\mu\text{Pa}^2\text{-s}$).

23
24 The acoustic abilities of bottlenose dolphins are well known including their response to
25 anthropogenic sounds such as sonar or airguns. The bottlenose dolphin produces whistles in the
26 range of 0.8 to 24 kHz with dominant frequencies of 3.5 to 14.5 kHz a low frequency band of
27 sounds less than 2.0 kHz with dominant frequencies in the range of 0.3 to 0.9 kHz (Richardson et
28 al. 1995). The echolocation clicks of the bottlenose dolphin are in the range of 110 to 130 kHz
29 (Au 1993). Audiograms of bottlenose dolphins show their range of hearing is approximately 0.1
30 to 150 kHz (reviews by Richardson et al. 1995, Nedwell 2004). Bottlenose dolphins showed
31 different reactions to boats, movement away or indifference, depending on the area, amount of
32 boat activity and social behavior at the time of exposure (reviewed by Richardson et al. 1995).
33 They did respond to mid-frequency tones (0.4 to 75 kHz tones at exposure levels of 100 to 201
34 dB re 1 $\mu\text{Pa}^2\text{-s}$) in a laboratory setting (Schlundt et al. 2000, Finneran et al. 2005).

35
36 Sonar operations will only cause temporary non-injury physiological or behavioral effects to
37 bottlenose dolphins and will have negligible impact on annual survival, recruitment and birth
38 rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects
39 to bottlenose dolphins.

40 **6.2.8.13 Melon-Headed Whale (*Peponocephala electra*)**

41 The abundance estimate of melon-headed whales in the EEZ of the Hawaiian Islands is 2,947
42 (CV = 1.11) with the offshore waters their primary habitat (density estimate of 0.0012/km²,
43 Table 3-2). The acoustic effect analysis estimates that a total of 625 melon-headed whales will
44 be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The

analysis estimates that 4 will be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 $\mu\text{Pa}^2\text{-s}$) and 621 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 $\mu\text{Pa}^2\text{-s}$).

There is no information on the response of melon-headed whales exposed to anthropogenic sounds. There is little information on the acoustic abilities of melon headed whales but they produce whistles in the range of 0.5 to at least 20 kHz with the dominant frequencies at 2 to 14 kHz (Richardson et al. 1995). There is no information on the echolocation frequencies of melon headed whales, but long finned pilot whales produce echolocation clicks in the range of 6 to 11 kHz (Au 1993). Like many other species of odonticetes, melon headed whales will likely dive and move away from the active sonar ship.

Sonar operations will only cause temporary non-injury physiological or behavioral effects to melon-headed whales and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to melon-headed whales.

6.2.8.14 Spinner Dolphin (*Stenella longirostris*)

The abundance estimate of spinner dolphins in the EEZ of the Hawaiian Islands is 2,805 (CV = 0.66) with the inshore waters their primary habitat (density estimate of 0.0443/km², Table 3-2). The acoustic effect analysis estimates that a total of 2,813 spinner dolphins will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that 37 may be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 $\mu\text{Pa}^2\text{-s}$) and 2,776 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 $\mu\text{Pa}^2\text{-s}$).

There is little information on the acoustic abilities of the spinner dolphin. They produce whistles in the range of 1 to 22.5 kHz with the dominant frequency being 6.8 to 17.9 kHz, above that of the active sonar frequencies, although their full range of hearing may extend down to 1 kHz or below as reported for other small odonticetes (Richardson et al. 1995, Nedwell et al. 2004). They also display pulse burst sounds in the range of 5 to 60 kHz. Their echolocation clicks range up to at least 65 kHz (Richardson et al. 1995). Active sonars may temporarily mask some sounds in the lower range of spinner dolphin hearing and may also cause a behavioral response.

Sonar operations will only cause temporary non-injury physiological or behavioral effects to spinner dolphins and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to spinner dolphins.

6.2.8.15 Risso's Dolphin (*Grampus griseus*)

The abundance estimate of Risso's dolphins in the EEZ of the Hawaiian Islands is 2,351 (CV = 0.65) with the offshore waters their primary habitat (density estimate of 0.0010/km², Table 3-2). The acoustic effect analysis estimates that a total of 446 Risso's dolphins will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that 3 will be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 $\mu\text{Pa}^2\text{-s}$) and 443 will be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 $\mu\text{Pa}^2\text{-s}$).

Risso's dolphins produce whistles in the range of 3.5 to 4.5 kHz, pulse bursts in the range of 0.1 to at least 8 kHz (Richardson et al. 1995), and echolocation sounds in the range of 30 to 70 kHz (Madsen et al. 1994). The audiogram of the Risso's dolphin shows that they hear from about 8 to 100 kHz (Nachtigall et al. 1995). Their echolocation clicks range up to at least 65 kHz (Au 1993). Active sonars may temporarily mask some sounds in the lower range of Risso's dolphin hearing and may also cause a behavioral response.

Sonar operations will only cause temporary non-injury physiological or behavioral effects to Risso's dolphins and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to Risso's dolphins.

6.2.8.16 Blainville's Beaked Whale (*Mesoplodon densirostris*)

The abundance estimate of Blainville's beaked whales in the EEZ of the Hawaiian Islands is 2,138 (CV = 0.77) using both the inshore and offshore water habitats (density estimate of 0.0009/km², Table 3-2). The acoustic effect analysis estimates that a total of 446 Blainville's beaked whales will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). However, the Level B harassment predicted for beaked whales is treated as non-lethal Level A harassment. The analysis estimates that 3 will be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 µPa²-s) and 443 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 µPa²-s).

There is no information on the response of Blainville beaked whales exposed to anthropogenic sounds. There is little information on the acoustic abilities of Blainville beaked whales, but other Ziphiid species have vocalizations in the range of <1.0 to 16 kHz (Richardson et al. 1995).

Preliminary information on the diving of Blainville beaked whales show dives up to 890 m and durations of up to 23.3 min (Baird et al. 2004). Like many other species of odontocetes, Cuvier's beaked whales will likely dive and move away from the active sonar ship.

Sonar operations will only cause temporary non-injury physiological or behavioral effects to Blainville's beaked whales and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to Blainville's beaked whales.

6.2.8.17 Longman's Beaked Whale (*Indopacetus pacificus*)

The abundance estimate of Longman's beaked whales in the EEZ of the Hawaiian Islands is 766 (CV = 1.05), using the offshore water habitat (density estimate of 0.0003 /km², Table 3-2). The acoustic effect analysis estimates that a total of 140 Longman's beaked whales will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). However, the Level B harassment predicted for beaked whales is treated as non-lethal Level A harassment. The analysis estimates that none will be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 µPa²-s) and 140 may be taken by temporary behavioral effects (EL of 173 to 195 dB re 1 µPa²-s).

1 It is very likely, however, that lookouts would detect a group of Longman's beaked whales at the
2 surface given their size (up to 24.6 ft [7.5 m]) and large mean group size of 17.8 animals
3 (probability of trackline detection = 0.76; Barlow 2003). It is, therefore, unlikely that RIMPAC
4 ASW training events would affect Longman's beaked whales. It is remotely possible that
5 Longman's beaked could, due to their ability to remain submerged for long periods of time, be
6 present and undetected in the vicinity of a RIMPAC ASW training event.

8 Longman's beaked whales were previously classified within the genus *Mesoplodon*, but recently
9 it was confirmed that it should be in its own genus (Dalebout et al. 2003). There is no
10 information on the acoustic abilities of Longman's beaked whale or their response when exposed
11 to anthropogenic sounds. Other beaked whale species have vocalizations in the range of <1.0 to
12 16 kHz (Richardson et al. 1995). Beaked whales tend to make deep and long duration dives
13 (Baird et al. 2004) and will likely move away from the vessels (Wursig et al. 1998). Even
14 though any undetected Longman's beaked whales transiting the proposed RIMPAC ASW
15 training areas may exhibit a reaction when initially exposed to active acoustic energy, field
16 observations indicate the effects would not cause disruption of natural behavioral patterns to a
17 point where such behavioral patterns would be abandoned or significantly altered.

19 Based on the model results, behavioral patterns, results of past RIMPAC Exercises, and the
20 implementation of standard operating procedure protective measures, the Navy finds that the
21 RIMPAC ASW training events are unlikely to result in harassment of Longman's beaked whales.
22 The Navy therefore concludes that the RIMPAC ASW training events may affect but will not
23 adversely affect Longman's beaked whales. Sonar operations will only cause temporary non-
24 injury physiological or behavioral effects to Longman's beaked whales and will have negligible
25 impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter
26 11 would reduce the potential for adverse effects to Longman's beaked whales.

28 **6.2.8.18 Pygmy Killer Whale (*Feresa attenuata*)**

29 The abundance estimate of pygmy killer whales in the EEZ of the Hawaiian Islands is 817 (CV =
30 1.12, using the offshore water habitat (density estimate of 0.0003 /km², Table 3-2). The acoustic
31 effect analysis estimates that a total of 140 pygmy killer whales will be taken by non-injury
32 Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that
33 none will be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 $\mu\text{Pa}^2\text{-s}$)
34 and 140 may be taken by temporary behavioral effects (EL of 173 to 195 dB re 1 $\mu\text{Pa}^2\text{-s}$).

36 It is very likely, however, that lookouts would detect a group of pygmy killer whales at the
37 surface given their size (up to 8.5 ft [2.6 m]), aerial leaps, pronounced dorsal fin and large mean
38 group size of 14.4 animals (probability of trackline detection = 0.76; Barlow 2003). It is,
39 therefore, unlikely that RIMPAC ASW training events would affect pygmy killer whales. It is
40 remotely possible that pygmy killer whales could be present and undetected in the vicinity of a
41 RIMPAC ASW training event.

43 There is little information on the acoustic abilities of pygmy killer whales. Pygmy killer whales
44 produce echolocation sounds in the range of 45 to 117 kHz with source levels of 197 to 223 dB
45 re 1 μPa^2 at 1 m (Madsen et al. 2004). Pygmy killer whales may have a similar hearing range to
46 false killer whales of 2.0 to 110 kHz (Thomas et al. 1988) with the best sensitivity from 16 to 24

kHz (Yuen et al. 2005). Pygmy killer whales are known to avoid boats, though there are reports of bow- and wake-riding (Carwardine, 1995). Even though any undetected pygmy killer whales transiting the proposed RIMPAC ASW training areas may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered.

Based on the model results, behavioral patterns, results of past RIMPAC Exercises, and the implementation of standard operating procedure protective measures, the Navy finds that the RIMPAC ASW training events are unlikely to result in harassment of pygmy sperm whales. The Navy therefore concludes that the RIMPAC ASW training events may affect but will not adversely affect false killer whales. Sonar operations will only cause temporary non-injury physiological or behavioral effects to pygmy sperm whales and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to Pygmy killer whales.

6.2.8.19 Bryde's Whale (*Balaenoptera edeni*)

The abundance estimate of Bryde's whales in the EEZ of the Hawaiian Islands is 493 (CV = 0.34) using the offshore water habitat (density estimate of 0.0002/km², Table 3-2). The acoustic effect analysis estimates that a total of 96 Bryde's whales will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that none will be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 µPa²-s) and 96 may be taken by temporary behavioral effects (EL of 173 to 195 dB re 1 µPa²-s).

It is very likely, however, that lookouts would detect a group of fin whales at the surface given their large size (up to 50 ft [15.2 m]), pronounced blow, and group size of approximately two to three animals (probability of trackline detection = 0.90; Barlow 2003). It is, therefore, very unlikely that RIMPAC ASW training events would affect Bryde's whales. It is remotely possible that Bryde's whales could, due to their ability to remain submerged for long periods of time, be present and undetected in the vicinity of a RIMPAC ASW training event.

There is no information on the response of Bryde's whales exposed to anthropogenic sounds. Bryde's whales have vocalizations in the range of 70 to 900 Hz with source levels of up to 174 dB re 1µPa at 1 m (Cummings et al 1986; Edds et al. 1993). There are no audiograms of baleen whales, but they tend to react to anthropogenic sound below 1 kHz, and most of their vocalizations are also in that range, suggesting that they are more sensitive to low frequency sounds (Richardson et al. 1995). Bryde's whales showed little response to slowly moving boats approaching at a steady speed (Watkins 1981) and may even approach ships (Cummings et al. 1986). Bryde's whales are easier to approach when feeding (Gallardo et al. 1983). Preliminary information on the diving of Bryde's whales shows dives up to 15 minutes (Tershy et al. 1993).

Even though any undetected Bryde's whales transiting the proposed RIMPAC ASW training areas may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered.

Based on the model results, behavioral patterns, results of past RIMPAC Exercises, and the implementation of standard operating procedure protective measures, the Navy finds that the RIMPAC ASW training events are unlikely to result in harassment of Bryde's whales. The Navy therefore concludes that the RIMPAC ASW training events may affect but will not adversely affect Bryde's whales. Sonar operations will only cause temporary non-injury physiological or behavioral effects to a small number of Bryde's whales and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to Bryde's whales.

6.2.8.20 Killer Whale (*Orcinus orca*)

The abundance estimate of killer whales in the EEZ of the Hawaiian Islands is 430 (CV = 0.72, using the offshore water habitat (density estimate of 0.002 /km², Table 3-2). The acoustic effect analysis estimates that a total of 96 killer whales will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that none will be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 μ Pa²-s) and 96 may be taken by temporary behavioral effects (EL of 173 to 195 dB re 1 μ Pa²-s).

It is very likely, however, that lookouts would detect a group of killer whales at the surface given their size (up to 23 ft [7.0 m]), pronounce dorsal fin and large mean group size of 6.5 animals (probability of trackline detection = 0.90; Barlow 2003). It is, therefore, very unlikely that RIMPAC ASW training events would affect killer whales. It is remotely possible that killer whales could, due to their ability to remain submerged for long periods of time, be present and undetected in the vicinity of a RIMPAC ASW training event.

Killer whales produce whistles and pulsed calls in the range of 0.5 to 12 kHz (reviewed by Richardson et al. 1995) and echolocation sounds in the range of 12 to 25 kHz with source levels of 173 dB re 1 μ Pa² at 1 m (Diercks et al. 1971). Killer whales hear in the range of 1.0 to approximately 120 kHz with the best sensitivity from 8 to 30 kHz (Hall and Johnson 1972; Bain et al. 1993; Szymanski et al. 1999). Killer whales are exposed to a high level of boat traffic from whale watching boats in British Columbia but only show a small tendency to move away and to swim faster (Kruse 1991). Even though any undetected killer whales transiting the proposed RIMPAC ASW training areas may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered. Based on the model results, behavioral patterns, results of past RIMPAC Exercises, and the implementation of standard operating procedure protective measures, the Navy finds that the RIMPAC ASW training events are unlikely to result in harassment of false killer whales. The Navy therefore concludes that the RIMPAC ASW training events may affect but will not adversely affect killer whales. Sonar operations will only cause temporary non-injury physiological or behavioral effects to a small number of killer whales and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to killer whales.

6.2.8.21 False Killer Whale (*Pseudorca crassidens*)

The abundance estimate of false killer whales in the EEZ of the Hawaiian Islands is 268 (CV = 1.08, using both the inshore and offshore water habitats (density estimate of 0.0017 /km² and 0.0001/km², Table 3-2). The acoustic effect analysis estimates that a total of 137 false killer whales will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that none will be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 μ Pa²-s) and 137 may be taken by temporary behavioral effects (EL of 173 to 195 dB re 1 μ Pa²-s).

It is very likely, however, that lookouts would detect a group of false killer whales at the surface given their size (up to 19.7 ft [6.0 m]) and large mean group size of 10.3 animals (probability of trackline detection = 0.76; Barlow 2003). It is, therefore, very unlikely that RIMPAC ASW training events would affect false killer whales. It is remotely possible that false killer whales could, due to their ability to remain submerged for long periods of time, be present and undetected in the vicinity of a RIMPAC ASW training event.

There is no information on the response of false killer whales exposed to anthropogenic sounds. False killer whales produce whistles in the range of 4.0 to 9.5 kHz (Kamminga and van Velden 1987) and echolocation sounds in the range of 25 to 30 kHz and 95 to 130 kHz with source levels of 200 to 228 dB re 1 μ Pa² at 1 m (Kamminga and van Velden 1987; Thomas and Turl 1990). False killer whales hear in the range of 2.0 to 110 kHz (Thomas et al. 1988) with the best sensitivity from 16 to 24 kHz (Yuen et al. 2005). Captive false killer whales showed some reaction to pulse sounds from 24 to 115 kHz at received levels of approximately 174 dB re 1 μ Pa² at 1 m (Akamatsu et al. 1993). Even though any undetected false killer whales transiting the proposed RIMPAC ASW training areas may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered.

Based on the model results, behavioral patterns, results of past RIMPAC Exercises, and the implementation of standard operating procedure protective measures, the Navy finds that the RIMPAC ASW training events are unlikely to result in harassment of false killer whales. The Navy therefore concludes that the RIMPAC ASW training events may affect but will not adversely affect false killer whales. Sonar operations will only cause temporary non-injury physiological or behavioral effects to false killer whales and will have negligible impact on annual survival, recruitment and birth rates. Protective measures presented in Chapter 11 would reduce the potential for adverse effects to false killer whales.

6.2.8.22 *Stenella spp*

Dolphins of the genus *Stenella* use the inshore waters as their primary habitat (density estimate of 0.0076/km², Table 3-2). The acoustic effect analysis estimates that a total of 415 *Stenella* spp. will be taken by non-injury Level B harassment and none by Level A harassment (Table 6-2). The analysis estimates that 3 will be taken by temporary physiological effects (TTS, EL of 195 to 215 dB re 1 μ Pa²-s), and 412 may be taken by temporary behavioral effects (EL of 190 to 195 dB re 1 μ Pa²-s).

1 There is little information on the acoustic abilities of the *Stenella* spp. Spinner and spotted
2 dolphins produce whistles in the range of 1 to at least 24 kHz with the dominant frequency being
3 6.8 to 17.9 kHz. Their echolocation clicks range up to 65 kHz (Richardson et al. 1995).
4 Audiograms of striped dolphins had a range of 0.5 to 160 kHz with the most sensitive hearing in
5 the range of 29 to 123 kHz, above that of the active sonar frequencies. Active sonars may
6 temporarily mask some sounds in the lower range of spinner dolphin hearing and may also cause
7 a behavioral response.

8
9 Sonar operations will only cause temporary non-injury physiological or behavioral effects to
10 *Stenella* spp. and will have negligible impact on annual survival, recruitment and birth rates.
11 Protective measures presented in Chapter 11 would reduce the potential for adverse effects to
12 *Stenella* spp. dolphins.
13

14 **6.2.8.23 Hawaiian Monk Seal (*Moanachus scauinslandi*)**

15 Hawaiian monk seals are also endangered and are of additional concern. There are
16 approximately 55 monk seals in the main Hawaiian Islands (DoN 2005a). Since there are no
17 density estimates for monk seals, exposures were modeled using density numbers for fin whales.
18 The acoustic effects analysis predicts that RIMPAC training events could result in the
19 harassment of one monk seal at the temporary physiological effects level (TTS, EL of 195 to 215
20 dB re 1 $\mu\text{Pa}^2\text{-s}$). However, the majority of the sonar training events will take place in the deep
21 ocean far offshore of the main islands, beyond the primary and secondary occurrence areas for
22 monk seals. Primary occurrence of monk seals in the Main Hawaiian Islands is expected in a
23 continuous band between Kaula Rock, Niihau, and Kauai. This band extends from the shore to
24 around the 500 m isobath. An area of secondary occurrence is expected from the 500 m isobath
25 to the 1,000 m isobath around Kaula Rock, Niihau, and Kauai. A continuous area of secondary
26 occurrence is also expected from the shore to the 1,000 m isobath around the other Main
27 Hawaiian Islands.
28

29 While it is possible that they may be affected, it is not likely that monk seals would be adversely
30 affected given no evidence suggestive of any effects by any of the previous 19 RIMPAC
31 Exercises. The protective measures presented in Chapter 11 would further reduce the potential
32 for acoustic effects to monk seals to a level such that they are unlikely to occur.
33
34

35 **7. IMPACTS TO MARINE MAMMAL SPECIES OR STOCKS**

36 Overall, the conclusions in this analysis find that impacts to marine mammal species and stocks
37 would be negligible for the following reasons:
38

- 39 • The acoustic harassments are within the *non-injurious* TTS or behavioral effects zones.
40 No exposures to sound levels causing PTS/injury (Level A harassment) are expected to
41 occur with the exception of the special consideration given for beaked whales.
- 42 • The Level B harassment predicted for beaked whales is treated as non-lethal Level A
43 harassment.
- 44 • Although the numbers presented in Table 6-2 represent estimated harassment under the
45 MMPA, as described above, they are conservative estimates of harassment by behavioral

disturbance. In addition the model calculates harassment without taking into consideration standard protective measures, and is not indicative of a likelihood of either injury or harm.

- Additionally, the protective measures described in Chapter 11 are designed to reduce sound exposure of marine mammals to levels below those that may cause “behavioral disruptions.”

Consideration of negligible impact is required for NMFS to authorize incidental take of marine mammals. By definition, an activity has a “negligible impact” on a species or stock when it is determined that the total taking is not likely to reduce annual rates of adult survival or recruitment (i.e., offspring survival, birth rates). Based on each species’ life history information, the expected behavioral patterns in the RIMPAC locations, and an analysis of the behavioral disturbance levels in comparison to the overall population, an analysis of the potential impacts of the Proposed Action on species recruitment or survival is presented in Subchapter 6.2.7 for each species. These species-specific analyses support the conclusion that proposed RIMPAC ASW training events would have a negligible impact on marine mammals.

8. IMPACT ON SUBSISTENCE USE

Potential impacts resulting from the Proposed Action will be limited to individuals of marine mammal species located in the Hawaiian Islands Operating Area that have no subsistence requirements. Therefore, no impacts on the availability of species or stocks for subsistence use are considered.

9. IMPACTS TO MARINE MAMMAL HABITAT AND THE LIKELIHOOD OF RESTORATION

The primary source of marine mammal habitat impact is exposures resulting from ASW activities. However, the exposures do not constitute a long-term physical alteration of the water column or bottom topography, as the occurrences are of limited duration and are intermittent in time. Surface vessels associated with the activities are present in limited duration and are intermittent as well.

Other sources that may affect marine mammal habitat were considered and potentially include the introduction of fuel, debris, ordnance, and chemical residues into the water column. The effects of each of these components were considered in the RIMPAC PEA and Supplements and were determined to not likely adversely affect protected marine species. Marine mammal habitat would not be affected.

10. IMPACTS TO MARINE MAMMALS FROM LOSS OR MODIFICATION OF HABITAT

Based on the discussions in Chapter 9, there will be no impacts to marine mammals resulting from loss or modification of marine mammal habitat.

11. MEANS OF EFFECTING THE LEAST PRACTICABLE ADVERSE IMPACTS—PROTECTIVE MEASURES

11.1 Protective Measures Related to Acoustic Effects

Effective training in the proposed RIMPAC ASW areas dictates that ship, submarine, and aircraft participants utilize their sensors and exercise weapons to their optimum capabilities as required by the mission. The Navy recognizes that such use has the potential to cause behavioral disruption of some marine mammal species in the vicinity of an exercise (as outlined in Chapter 4). Although any disruption of natural behavioral patterns is not likely to be to a point where such behavioral patterns are abandoned or significantly altered, this chapter presents the Navy's protective measures, outlining steps that would be implemented to protect marine mammals and Federally listed species during RIMPAC operations. It should be noted that these protective measures have been standard operating procedures for unit level ASW training since 2004 and were implemented for previous RIMPAC exercises; their implementation during RIMPAC 2006 will not be new. This chapter also presents a discussion of other measures that have been considered and rejected because they are either: (1) not feasible; (2) present a safety concern; (3) provide no known or ambiguous protective benefit; or (4) impact the effectiveness of the required ASW training military readiness activity.

11.1.1 Personnel Training

Navy shipboard lookout(s) are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the Officer of the Deck (e.g., trash, a periscope, a marine mammal) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water.

Navy lookouts undergo extensive training in order to qualify as a watchstander. This training includes on-the-job instruction under the supervision of an experienced watchstander, followed by completion of the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). In addition to these requirements, many Fleet lookouts periodically undergo a 2-day refresher training course.

The Navy includes marine species awareness as part of its training for its bridge lookout personnel on ships and submarines. Marine species awareness training was updated in 2005 and the additional training materials are now included as required training for Navy lookouts. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information to aid in avoiding interactions with marine species. Marine species awareness and training is reemphasized by the following means:

- **Bridge personnel on ships and submarines**—Personnel utilize marine species awareness training techniques as standard operating procedure, they have available the “whale wheel” identification aid when marine mammals are sighted, and they receive updates to the current marine species awareness training as appropriate.
- **Aviation units**—All pilots and aircrew personnel, whose airborne duties during ASW operations include searching for submarine periscopes, report the presence of marine species in the vicinity of exercise participants.
- **Sonar personnel on ships, submarines, and ASW aircraft**—Both passive and active sonar operators on ships, submarines, and aircraft utilize protective measures relative to their platform. The Environmental Annex to the RIMPAC Operational Order mandates specific actions to be taken if a marine mammal is detected and these actions are standard operating procedure throughout the exercise.

Implementation of these protective measures is a requirement and involves the chain of command with supervision of the activities and consequences for failing to follow orders. Activities undertaken on a Navy vessel or aircraft are highly controlled. Very few actions are undertaken on a Navy vessel or aircraft without oversight by and knowledge of the chain of command. Failure to follow the orders of one’s superior in the chain of command can result in disciplinary action.

11.1.2 Operating Procedures

The following procedures are implemented to maximize the ability of operators to recognize instances when marine mammals are close aboard and avoid adverse effects to listed species:

- **Visual detection/ships and submarines**—Ships and surfaced submarines have personnel on lookout with binoculars at all times when the vessel is moving through the water. Standard operating procedure requires these lookouts maintain surveillance of the area visible around their vessel and to report the sighting of any marine species, disturbance to the water’s surface, or object (unknown or otherwise) to the Officer in command.
- **Visual detection/aircraft**—Aircraft participating in RIMPAC ASW events will conduct and maintain, whenever possible, surveillance for marine species prior to and during the event. The ability to effectively perform visual searches by participating aircraft crew will be heavily dependent upon the primary duties assigned as well as weather, visibility, and sea conditions. Sightings would be immediately reported to ships in the vicinity of the event as appropriate.
- **Passive detection for submarines**—Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASUW/ASW operations involving active mid-frequency sonar. This will include measures for estimating marine mammals close aboard and range using bearings only/bearing rate procedures.

When marine mammals are detected close aboard, all ships, submarines, and aircraft engaged in ASW would reduce mid-frequency active sonar power levels in accordance with the following specific actions:

- When whales or dolphins are detected by any means (aircraft, lookout, or aurally) within 450 yards of the sonar dome (the bow), the ship or submarine will limit active transmission levels to at least 6 dB below the equipment's normal operating level for sector search modes. Within the water depths encompassed by the proposed RIMPAC areas, a 6-dB reduction in ping levels would reduce the range of potential acoustic effects to about half of its original distance. This, in turn, would reduce the area of acoustic effects to about one quarter of its original size.
- Ships and submarines would continue to limit maximum ping levels by this 6-dB factor until they assess that the marine mammal is no longer within 450 yards of the sonar dome. Should the marine mammal be detected closing to inside 200 yards of the sonar dome, active sonar transmissions will cease.
- When a marine mammal or sea turtle is detected closing to inside approximately 200 yards of the sonar dome, the principal risk becomes potential physical injury from collision. Accordingly, ships and submarines shall maneuver to avoid collision if the marine species closes within 200 yards to the extent possible, with safety of the vessel being paramount.
- Helicopters shall observe/survey the vicinity of an event location for 10 minutes before deploying active (dipping) sonar in the water. Helicopters shall not dip their sonar within 200 yards of a marine mammal and shall secure pinging if a marine mammal closes within 200 yards after pinging has begun.

The RIMPAC Operational Order Environmental Annex (Appendix A) includes these specific measures that are to be followed by all exercise participants.

11.1.3 Alternative Protective Measures Considered but Eliminated

As described in Chapter 4, estimated sound exposures to marine mammals during proposed RIMPAC training activities will not cause injury. Potential marine mammal acoustic exposures that may result in harassment and/or a behavioral reaction are further reduced by the protective measures described above. Therefore, the Navy concludes that the Proposed Action and protective measures achieve the least practical adverse impact on species or stocks of marine species.

Several additional protective measures were analyzed and **eliminated** from further consideration given consideration of personnel safety, practicality of implementation, effectiveness as a protective measure, and impact on the effectiveness of the military readiness activity:

1. Use of third-party personnel onboard Navy vessels to provide surveillance of ASW or other exercise events.

- a. Use of third-party observers is not necessary given that Navy personnel are extensively trained in spotting items at or near the water surface. Navy personnel receive more hours of training, and utilize their skills more frequently, than many third party-trained personnel.
 - b. Use of Navy observers is the most effective means to ensure quick and effective communication within the command structure and facilitate implementation of protective measures if marine species are spotted. A critical skill set of effective Navy training is communication. Navy personnel are trained to act swiftly and decisively to ensure that information is passed to the appropriate supervisory personnel.
 - c. Some training events during RIMPAC will span one or more 24-hour period with operations underway continuously in that timeframe. It is not feasible to maintain third-party surveillance of these operations given the number of third-party personnel that would be required onboard.
 - d. Surface ships having active mid-frequency sonar (DDG, FFG, CG) have berthing capacity that is limited. Exercise planning includes careful consideration of this limited capacity in the placement of exercise controllers, data collection personnel, and Afloat Training Group personnel on ships involved in the exercise. Inclusion of third-party observers onboard these ships would require that in some cases, there would be no additional berthing space for the Navy personnel required to fully evaluate and efficiently use the training opportunity to accomplish the exercise objectives.
 - e. Implicit in the suggestion to have third-party personnel onboard Navy vessels to provide marine mammal surveillance, is that Navy personnel are incapable of performing the same function (recognizing the presence of a marine mammal). Navy rejects this assumption as erroneous.
 - f. Navy and NMFS have not developed the necessary lengthy and detailed procedures that would be required to facilitate the integration of information from non-Navy observers into the command structure.
 - g. Security clearance issues would have to be overcome to allow non-Navy observers onboard exercise participants.
2. Visual monitoring or surveillance using third-party observers from air or vessels to survey before, during, and after exercise events.
 - a. Use of third-party observers in the air or on civilian vessels compromises security due to the requirement to provide advance notification of specific times/locations of Navy platforms (this information is Classified).
 - b. The areas where RIMPAC ASW events will mainly occur (the representative ASW areas modeled) covers approximately 46,000 square nautical miles. Contiguous ASW events may cover many hundreds of square miles. The number of civilian ships and/or aircraft required to monitor the area of these events would be considerable. It is thus, not feasible to survey or monitor the large exercise areas in the time required to ensure these areas are devoid of marine mammals. In addition, marine mammals may move into or out of an area, if surveyed before an event, or an animal could move into an area after an exercise took place. Given that there are no adequate controls to account for these or other possibilities and

there are no identified research objectives, there is no utility to performing either a before or an after-the-event survey of an exercise area.

- c. Survey during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, most of the training events take place far from land, limiting both the time available for civilian aircraft to be in the exercise area and presenting a concern should aircraft mechanical problems arise.
- d. Scheduling civilian vessels or aircraft to coincide with ASW events would impact training effectiveness since exercise event timetables can not be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the unceasing progress of the exercise and impact the effectiveness of the military readiness activity.
- e. The vast majority of RIMPAC training events involve a Navy aerial asset with crews specifically training to hone their detection of objects in the water. The capability of sighting from both surface and aerial platforms provides excellent survey capabilities using the Navy's existing exercise assets.
- f. Multiple events may occur simultaneously in areas at opposite ends of the Main Hawaiian Islands and then continue for up to 96 hours. There are not enough qualified third-party personnel to accomplish the monitoring task.
- g. There is no identified research design, sampling procedures, or purpose for any survey or monitoring effort.

3. Seasonal, Problematic Complex/Steep Bathymetry, or Habitat Avoidance

- a. Seasonal avoidance is a measure that is not compatible with the schedule of the RIMPAC Exercise. RIMPAC does, however, take place in the summer when there is a lower overall density of marine mammals in the Hawaiian Islands.
- b. Areas between islands and areas with complex, steep bathymetry generally characterize the majority of the bathymetry in proximity to the volcanic islands forming the Hawaiian Island chain. The implicit assumption of this proposed measure is that use of active sonar in areas between islands and in areas with complex, steep bathymetry is problematic for marine mammals. There is no evidence to indicate or even suggest these areas are problematic for marine mammal species in the Hawaiian Islands. In addition, it is a requirement that the Navy train to be able to protect vessels moving between islands or landmasses. Avoidance of these areas would eliminate one of the major objectives in the RIMPAC Exercise and thus impact the effectiveness of the training.
- c. The habitat requirements for most of the marine mammals in the Hawaiian Islands is unknown and is not likely based on precise static locations. There is no information available on possible alternative exercise locations or environmental factors that would otherwise be less important to marine mammals in the Hawaiian Islands. In addition, exercise locations were very carefully chosen by exercise planners based on training requirements and the ability of ships and submarines to operate safely. Moving the exercise events to alternative locations would impact the effectiveness of the training and has no know utility.

- 1 4. Use of active sonar with output levels as low as possible consistent with mission
2 requirements and use of active sonar only when necessary.
 - 3 a. Operators of sonar equipment are always cognizant of the environmental variables
4 effecting sound propagation. In this regard the sonar equipment power levels are
5 always set consistent with mission requirements.
 - 6 b. Active sonar is only used when required by the mission since it has the potential
7 to alert opposing forces to the sonar platform's presence. Passive sonar and all
8 other sensors are used in concert with active sonar to the maximum extent
9 practical when available and when required by the mission.
- 10 5. Suspension of the exercise at night, periods of low visibility, and in high sea-states when
11 marine mammals are not readily visible.
 - 12 a. It is imperative that the Navy be able to operate at night, in periods of low
13 visibility, and in high sea-states. The Navy must train as we are expected to fight
14 and adopting this prohibition would eliminate this critical military readiness
15 requirement.
- 16 6. Scaling down the exercise to meet core aims
 - 17 a. Training exercises are always constrained by the availability of funding,
18 resources, personnel, and equipment with the result being they are always scaled
19 down to meet only the core requirements.
- 20 7. Limit the active sonar event locations
 - 21 a. Areas where events are scheduled to occur are carefully chosen to provide for the
22 safety of operations and to allow for the realistic tactical development of the
23 exercise scenario. Otherwise limiting the exercise to a few areas would adversely
24 impact the effectiveness of the training.
 - 25 b. Limiting the exercise areas would concentrate all sonar use, resulting in
26 unnecessarily prolonged and intensive sound levels vice the more transient
27 exposures predicted by the current planning that makes use of multiple exercise
28 areas.
- 29 8. Passive Acoustic Monitoring
 - 30 a. As noted in the preceding section, passive detection capabilities are used to the
31 maximum extent practicable consistent with the mission requirements to alert
32 exercise participants to the presence of marine mammals in an event location.
- 33 9. Use of ramp-up to attempt to clear an area prior to the conduct of exercises.
 - 34 a. Ramp-up procedures involving slowly increasing the sound in the water to
35 necessary levels, have been utilized in other non-DoD activities. Ramp-up
36 procedures are not a viable alternative for training exercises, as the ramp-up
37 would alert opponents to the participants' presence and not allow the Navy to
38 train as they fight, thus adversely impacting the effectiveness of the military
39 readiness activity.
 - 40 b. Ramp-up for sonar as a protective measure, is also an unproven technique. The
41 implicit assumption is that animals would have an avoidance response to the low-
42 power sonar and would move away from the sound and exercise area, however,
43 there is no data to indicate this assumption is correct. Given there is no data to
44 indicate that this is even minimally effective and because ramp-up would have an
45 impact on the effectiveness of the military readiness activity, it was eliminated
46 from further consideration.
- 47 10. Reporting of marine mammal sightings to augment scientific data collection

- 1 a. Ships, submarines, aircraft, and personnel engaged the RIMPAC exercise are
2 intensively employed throughout the duration of the exercise. Their primary duty
3 is accomplishment of the exercise goals and they should not be burdened with
4 additional duties, unrelated to that task. Any additional workload assigned that is
5 unrelated to their primary duty, would adversely impact the effectiveness of the
6 military readiness activity they are undertaking.
- 7 11. Stop the RIMPAC Exercise if there is a marine mammals stranding
- 8 a. The Officer in Charge of the Exercise will order cessation of active sonar events
9 in an area where a stranding has occurred and where there is clear and credible
10 available evidence implicating active sonar in the stranding event.

11 11.1.4 Conservation Measures

12 The Navy will continue to fund ongoing marine mammal research in the Hawaiian Islands.
13 Results of conservation efforts by the Navy in other locations will also be used to support efforts
14 in the Hawaiian Islands. The Navy is coordinating long term monitoring/ studies of marine
15 mammals on various established ranges and operating areas:

- 17 • Coordinating with NMFS to conduct surveys within the selected Hawaiian Islands
18 Operating Area as part of a baseline monitoring program.
- 19 • Implementing a long-term monitoring program of marine mammal populations in the
20 Hawaiian Islands Operating Area, including evaluation of trends.
- 21 • Continuing Navy research and Navy contribution to university/external research to
22 improve the state of the science regarding marine species biology and acoustic
23 effects.
- 24 • Sharing data with NMFS and via the literature for research and development efforts.

26 The Navy has contracted with a consortium of researchers from Duke University, University of
27 North Carolina at Wilmington, University of St. Andrews, and the NMFS Northeast Fisheries
28 Science Center to conduct a pilot study analysis and develop a survey and monitoring plan that
29 lays out the recommended approach for surveys (aerial/shipboard, frequency, spatial extent, etc.)
30 and data analysis (standard line-transect, spatial modeling, etc.) necessary to establish a baseline
31 of protected species distribution and abundance and monitor for changes that might be attributed
32 to ASW operations on the Atlantic Fleet Undersea Warfare Training Range. The Research
33 Design for the project will be utilized in evaluating the potential for implementing similar
34 programs in the Hawaiian Islands ASW operations areas. In addition, a Statement of Interest has
35 been promulgated to initiate a similar research and monitoring project in the Hawaiian Islands
36 and the remainder of the Pacific Fleet OPAREAs. The execution of funding to begin the
37 resultant monitoring is planned for the fall of 2006.

12. MINIMIZATION OF ADVERSE EFFECTS ON SUBSISTENCE USE

Based on the discussions in Chapter 8, there are no impacts on the availability of species or
stocks for subsistence use.

13. MONITORING AND REPORTING MEASURES

The RIMPAC Operational Order Environmental Annex (see example in Appendix A) includes specific reporting requirements related to marine mammals. The Navy will continue to fund marine mammal research as outlined in the following Chapter.

14. RESEARCH

The Navy will continue to fund ongoing marine mammal research in the Hawaiian Islands. Results of conservation efforts by the Navy in other locations will also be used to support efforts in the Hawaiian Islands. The Navy is planning to coordinate long term monitoring/studies of marine mammals on various established ranges and operating areas:

- Coordinating with NMFS to conduct surveys within the selected Hawaiian Islands Operating Area as part of a baseline monitoring program.
- Implementing a long-term monitoring program of marine mammal populations in the Hawaiian Islands Operating Area, including evaluation of trends
- Continuing Navy research and Navy contribution to university/external research to improve the state of the science regarding marine species biology and acoustic effects
- Sharing data with NMFS and via the literature for research and development efforts

The Navy has contracted with a consortium of researchers from Duke University, University of North Carolina at Wilmington, University of St. Andrews, and the NMFS Northeast Fisheries Science Center to conduct a pilot study analysis and develop a survey and monitoring plan that lays out the recommended approach for surveys (aerial/shipboard, frequency, spatial extent, etc.) and data analysis (standard line-transect, spatial modeling, etc.) necessary to establish a baseline of protected species distribution and abundance and monitor for changes that might be attributed to ASW operations on the East Coast Underwater Training Range. The Research Design for the project will be utilized in evaluating the potential for implementing similar programs in the Hawaiian Islands ASW operations areas. In addition, a Statement of Interest has been promulgated to initiate a similar research and monitoring project in the Hawaiian Islands and the remainder of the Pacific Fleet OPAREAs, and the execution of funding to begin the resultant monitoring is planned for the fall of 2006.

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1 **Appendix A—RIMPAC 2004 Operational Order Environmental Annex**

2
3 ANNEX L TO EXERCISE RIMPAC 2004 OPORDER

4
5 ENVIRONMENTAL PROTECTION

6
7 References: (a) OPNAVINST 5090.1B, Environmental and Natural Resources Program
8 Manual, CH-4 of June 2003
9 (b) SOPAPEARLINST 5000.1F, Environmental Protection Guidance
10 (c) SECNAVINST 5090.7, Access to Ships and Shore Facilities, and Release
11 of information Regarding Navy Oil Spills
12

13 1. Responsibilities

14
15 a. CTF, BIF and MNF Commanders. Commanders are responsible for ensuring
16 all subordinate units comply with this Annex and applicable environmental laws and regulations.
17 References (a) and (b) detail United States Navy and Pearl Harbor environmental compliance
18 requirements. Applicable portions related to ships participating in RIMPAC 2006 are provided
19 in Appendices 1 and 2 of this Annex as well as online through the RIMPAC website.
20

21 b. Commanding Officers of Units.

22
23 (1) Commanding officers will comply, to the fullest extent practicable,
24 with the preventive measures outlined in this annex to prevent harm to marine mammals. Where
25 a specific preventive measure is impracticable, due to resource availability, asset allocation, or
26 other basis, the exercise may proceed if the specific preventive measure can be complied with by
27 alternative means sufficient to ensure minimal impact to the marine environment that the
28 measure was designed to protect.
29

30 (2) Commanding Officers will cooperate with Federal, State and local
31 government authorities in the prevention, control and abatement of environmental pollution as
32 required by reference (c). If requirements of an environmental law or regulation cannot be
33 achieved for any reason, including operational considerations or insufficient resources, the
34 Commanding Officer will report to the immediate superior in the chain of command and
35 Commander, THIRD Fleet as well as Commander Navy Region (COMNAVREG) Hawaii.
36

37 (3) Commanding Officers will be aware of all regulations regarding
38 pollution control in the vicinity of the Hawaiian Islands, and recommend remedial measures
39 when appropriate.
40

41 (4) Commanding Officers will seek assistance from Commander THIRD
42 Fleet and the Regional Environmental Coordinator, COMNAVREG Hawaii as needed to ensure
43 environmental compliance.
44

1 c. Regional Environmental Coordinator (REC). The REC for the Hawaiian
2 Islands, COMNAVREG Hawaii, can be reached at commercial (808) 471-1171 ext 229 (for
3 commercial and DSN), FAX (808) 471-1160.

4
5 (1) The REC will assist Commanders and Commanding Officers in
6 environmental compliance.

7
8 (2) The REC will conduct oil spill notification and response exercises.

9
10 (3) The Deputy Navy On-Scene Coordinator (NOSC) will operate the
11 COMNAVREG Hawaii oil spill hotline at (808)473-4689 or during off-duty hours at (808) 864-
12 2463 (cell).

13 14 2. Environmental Compliance for Afloat Units

15 16 a. Discharge Restrictions at Sea.

17
18 (1) A summary of discharge restrictions is contained in Appendix 1 of this
19 Annex, summarized from Chapter 19 of reference (a). Immediately contact Commander,
20 THIRD Fleet and the COMNAVREG Hawaii environmental counsel at (808) 473-4731 for
21 guidance if any difficulty is experienced in complying with these restrictions.

22
23 (2) In addition to the restrictions in Appendix 1, vessels should avoid
24 discharging any substance listed in Appendix 1 while operating within the 100-fathom [600-foot
25 (ft) or 183-meter (m)] isobaths in the areas between the islands of Maui, Molokai, Lanai, and
26 Kahoolawe.

27
28 b. Disposal in Port. All requests for disposal of wastes from ships should be
29 included in LOGREQs. Appendix 2 of this Annex is the applicable portion of the Commander,
30 U.S. Pacific Fleet, Senior Officer Present Afloat Pearl Harbor Instruction for disposal of wastes
31 by ships while in Pearl Harbor.

32 33 3. Underwater Explosives

34
35 a. Endangered/threatened marine species, including the humpback whale,
36 Hawaiian monk seal, green sea turtle, hawksbill sea turtle, and leatherback sea turtle, are present
37 in the waters and along the shorelines of the Hawaiian Islands. To ensure protection of these
38 animals, all shoreline and water areas, which may be affected by the detonation of explosive
39 charges or the use of explosive munitions, must be determined to be clear of protected marine
40 species prior to detonation or discharge. Commands planning or sponsoring any type of
41 underwater detonations must include COMNAVREG Hawaii N00L as an info addressee on all
42 requests for underwater detonations.

43
44 b. All mine warfare and mine countermeasure operations involving the use of
45 explosive charges must include safe zones for marine mammals (including humpback whales)
46 and sea turtles to prevent physical and/or acoustic harm to those species.

(1) For DEMO, pre-exercise survey shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. Appendix 4 to this Annex provides information on areas to be cleared with respect to explosive charge weights.

(2) The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal or sea turtle. Should such an animal be present within the survey area, the exercise shall be paused until the animal voluntarily leaves the area.

(3) Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event.

(4) Pre- and post-exercise surveys shall be reported to the Commander THIRD Fleet Judge Advocate and the COMNAVREG Hawaii environmental counsel at (808) 473-4731. Negative reports for post operations surveys are required. Any evidence of a marine mammal or sea turtle that may have been injured or killed by the action shall be reported immediately in accordance with procedures listed in Section 4.e(2) (that are applicable) of this document.

4. Ships/Aircraft Under Way. Prudent actions can reduce the risk of damage to ships, reduce the chances for injury to other marine mammals in the vicinity, and assist in future risk management analysis.

a. By law, no ship is to approach within 300 ft (90 m) of a humpback whale, and no any aircraft is to operate within 1,000 ft (300 m) or less of a humpback whale. Humpbacks are naturally inquisitive and historically have initiated close encounters despite best efforts to avoid them. Naval operations in the waters of the Hawaiian Islands Humpback Whale National Marine Sanctuary are authorized based in part on the Navy's practice of taking all reasonable precautions to avoid collisions with these endangered animals.

b. Ensure observers are briefed on the possible presence of marine mammals and that all sightings are reported to the bridge. Whales often travel in groups and a sighting indicates the possibility of others in the vicinity.

c. Upon sighting a whale, adjust course and speed as necessary to maintain a safe distance from the whales consistent with prudent seamanship.

d. Sightings of all whales shall be passed to other ships in the area to alert them to the possibility of the whales' presence.

e. In the event of a collision, if possible, take video and/or photographs of the stricken whale.

(1) Attempt to identify distinguishing characteristics of the whale involved. The "whale wheel," a device that lists various species of whales and their identifying features, can assist in this regard.

(2) Report all whale strikes via Unit SITREP or OPREP as appropriate. Whale strike report guidance and format is located in Annex L, Appendix 3, paragraph 2.

5. Gunnery Exercises (GUNNEX) Affecting Marine Environment

1 a. Non-explosive munitions:

2
3 (1) Establish a 600-ft (183-m) radius buffer zone around the intended
4 target.

5
6 (2) From the intended firing position, use observer(s) to survey for marine
7 mammals and sea turtles in and around the buffer zone prior to commencement and during the
8 exercise as long as practicable.

9
10 (3) Exercise shall be conducted only when the buffer zone is visible and
11 the area is visibly clear of marine mammals and sea turtles.

12
13 (4) Commence and continue exercise only if marine mammals and sea
14 turtles are not detected within the buffer zone.

15
16 b. Explosive munitions, Land Firing Points:

17
18 (1) Adhere to specific procedures and regulations of the range and the
19 requirements of this Appendix. For example, the PMRF Range Safety Officer requires that any
20 weapon fired on any PMRF range have a Range Safety Approval or a Range Safety Operational
21 Plan. The Exercise Program Manager and Operations Conductor must provide all range users a
22 safety brief prior to any exercise. For live fire with 155-mm howitzer, in addition to protecting
23 marine environment, temporary evacuation or appropriate hearing protection is required for all
24 non-participants on PMRF within the impacted area as delineated by the 140-dBP noise
25 contour/arc. Non-participants within the 140 dBP zone shall either (a) be inside buildings having
26 closed, non-jalousie type windows and wear ear plug hearing protection devices providing a
27 noise reduction rating (NRR) of at least 20 dB or (b) if outside or in buildings with jalousie type
28 windows or with open windows, wear hearing protection providing a NRR of at least 35 dB.
29 Consult with Range Safety Officer for details.

30
31 (2) Conduct range clearance flight within one hour prior to any weapons
32 being fired into the offshore ranges at PMRF to search visually for vessels, marine mammals,
33 and sea turtles. For live fire with 155-mm howitzer, establish a 2.5-mile [4.0-kilometer (km)]
34 radius buffer zone (to be cleared) around the intended target area.

35
36 (3) Within 30 minutes prior to the commencement of the firing exercise,
37 conduct an inspection of the beach and water areas from the firing line to the horizon, directly in
38 front of the firing line and laterally to 15 degrees on either side. If any marine mammals or sea
39 turtles are observed in the clearance areas, firing will not commence until the animals voluntarily
40 leave the area.

41
42 (4) Restrict entry of motorists and other members of the public into off-
43 station areas impacted by the 140 dBP noise contour for the duration of the firing. Make an
44 inspection of the beach areas within the 140 dBP zone, to ensure the area is clear of personnel.
45 Secure the beach at either end of the 140 dBP zone to ensure the area remains clear for the
46 duration of firing.

(5) Commence and continue exercise only if marine mammals and sea turtles are not detected within the buffer zone.

(6) Commence post-exercise surveys of the buffer areas within 30 minutes after completion of the firing.

(7) Pre- and post-exercise surveys shall be reported to the chain-of-command with copies to NAVFAC EFD Pacific ENV1832 at (808) 474-5923 and COMNAVREG Hawaii N465 at (808) 471-1171 x233. Negative reports for post operations surveys are required. Report any injured marine mammals and sea turtles to the Commander THIRD Fleet Judge Advocate and the COMNAVREG Hawaii environmental counsel at (808) 473-4731.

6. Practice bombing (explosive and non-explosive)

a. Establish a buffer zone around the intended target zone. See Appendix 4 to this Annex for information. In the future should similar information be required for other exercises or training evolutions not covered in Appendix 4, SPAWAR should be contacted at (619) 553-0021 for assistance. For SINKEX, a buffer zone with a 2.9 miles (4.6 km) radius around the intended target is required to be clear of non-exercise vessels, marine mammals, and sea turtles.

b. Visually survey the buffer zone for marine mammals and sea turtles one hour prior to and post (as safety allows) the exercise.

c. Visual survey to be conducted at an altitude of 1,500 ft (500 m) or lower to accomplish clearance survey of the impact area, if safe to do so, and at the slowest safe speed.

d. Survey aircraft should employ most effective search tactics and capabilities to increase the probability that marine mammals and sea turtles will be detected.

e. Conduct exercise only if the buffer zone is clear of marine mammals and sea turtles.

f. Do not release ordnance through cloud cover. Aircraft must be able to actually see ordnance impact areas.

7. Mine Countermeasures (mine hunting/mine sweeping/bottom mapping and survey/emplacement and retrieval of shallow water mines in littoral areas [e.g., Marine Corps Training Area Bellows (MCTAB)])

a. During small boat operations, note the presence of sea turtles and marine mammals.

1 b. Craft and personnel shall avoid direct contact with any marine mammal, sea
2 turtle, or living coral.

3
4 c. Mine shapes shall be emplaced only on sand/rubble bottoms not having living
5 coral reef development and where placement or removal of the shapes would not adversely
6 impact adjacent living corals. See paragraph 11.c for additional information.

7
8 d. At MCTAB, mine shapes shall not be placed in water of a depth less than 10
9 feet (9 m) MLLW, nor closer to shore than 300 ft (91 m). The top of the mine shape shall be a
10 minimum of 7 ft (2.1 m) below MLLW.

11
12 8. Hull-mounted surface and submarine active sonar.

13
14 a. Avoid critical habitats, marine sanctuaries, and the Humpback Whale
15 Sanctuary (see Annex A to Appendix L-3 in OORDER).

16
17 b. Surface vessels only: Use observers to visually survey for and avoid operating
18 active sonar when sea turtles and/or marine mammals are observed.

19
20 c. Submarines and surface units: Monitor acoustic detection devices for
21 indications of close aboard marine mammals (high bearing rate biologic contacts). When a
22 surface combatant or a submarine conducting active sonar training detects a marine mammal
23 close aboard, reduce maximum sonar transmission level to avoid harassment in accordance with
24 the following specific actions.

25
26 (1) When marine mammals are detected by any means (aircraft, observer,
27 or aurally) within 600 ft (183 m) of the sonar dome, the ship or submarine will limit active
28 transmission levels to at least 4 dB below their equipment maximum for sector search modes.

29
30 (2) Ship and submarines will continue to limit maximum transmission
31 levels by this 4 dB factor until they determine the marine mammal is no longer within 600 ft
32 (183 m) of the sonar dome.

33
34 (3) Should the marine mammal be detected closing to inside 300 ft (92 m)
35 of the sonar dome, the principal risk to the mammal changes from acoustic harassment to one of
36 potential physical injury from collision. Accordingly, ships and submarines shall maneuver to
37 avoid collision. Standard whale strike avoidance procedures apply.

38
39 (4) When seals are detected by any means within 1,050 ft (320 m) of the
40 sonar dome, the ship or submarine shall limit active transmission levels to at least 4 dB below
41 equipment maximum for sector search mode. Ships or submarines shall continue to limit
42 maximum ping levels by this 4 dB factor until the ships and submarines determine that the seal is
43 no longer within 1,050 ft (320 m) of the sonar dome.

44
45 (5) Special condition applicable for dolphins only. If after conducting an
46 initial maneuver to avoid close quarters with dolphins, the ship or submarine concludes that

dolphins are deliberately closing on the ship to ride the vessel's bow wave, no further mitigation actions are necessary. Note that while in the shallow, wave area of the vessel bow, dolphins are out of the main transmission axis of the mainframe active sonar and only exposed to significantly lower power levels.

9. Helo dipping sonar-training operations

a. Helos shall observe/survey the intended exercise area for marine mammals and sea turtles for a 10-minute duration before dipping active sonar transducer in the water.

b. Helos shall not dip their active sonar transducer within 600 ft (183 m) of a marine mammal or sea turtle.

c. If a marine mammal or sea turtle is detected while the helo has its sonar dipped and pinging, secure pinging if the marine mammal/sea turtle is located closing inside of 150 ft (46 m).

10. Invasive Species

a. Introduction of any plant or animal into Hawaii without permission of the Hawaii State Department of Agriculture is prohibited. Commanding Officers of all vessels shall, prior to arrival in Hawaii, ensure that all stores originating from Australia and Guam are inspected for the brown tree snake. This inspection may be accomplished during on-loading of such stores or while underway. Inspection records may be provided upon arrival in Hawaii to Department of Agriculture inspectors, who will inspect ships at berth for compliance with State animal quarantine laws. This inspection will not interfere with the granting of liberty.

b. Post-arrival action. If a snake is sighted aboard ship, aircraft, or during training exercises on land, restrain, contain, or kill the snake until appropriate authorities arrive. Immediately notify NAVSTA Pearl Harbor Security Police of all snake sightings at (808)471-7114 (24 hours).

c. For information regarding snakes, contact COMNAVREG Hawaii N465 at (808) 471-1171 x233.

d. Ensure all equipment and unmanned vehicles to be placed in ocean areas are clean and free from residual materials and invasive species from prior use (e.g., shapes, Seaglider, REMUS/BPAUV, etc.).

11. Coral Reef Protection

a. The United States has taken a number of steps in response to international concerns about coral reefs. One such measure was the establishment of the North-Western Hawaiian Islands Coral Reef Ecosystem Reserve (Reserve), by Executive Order 13178. The coverages are as follows:

(1) From the seaward boundary of Hawaii State waters and submerged lands to a mean depth of 600 ft (183 m) around:

- (a) Nihoa Island;
- (b) Necker Island;
- (c) French Frigate Shoals;
- (d) Gardner Pinnacles;
- (e) Maro Reef;
- (f) Laysan Island;
- (g) Lisianski Island;
- (h) Pearl and Hermes Atoll; and
- (i) Kure Island.

(2) 13.8 miles (22.2 km) round the approximate geographical centers of:

- (a) The first bank immediately east of French Frigate Shoals;
- (b) Southeast Brooks Bank, which is the first bank immediately west of French Frigate Shoals, provided that the closure area shall not be closer than approximately 3.5 miles (5.6 km) of the next bank immediately west;
- (c) St. Rogatien Bank, provided that the closure area shall not be closer than approximately 3.5 miles (5.6 km) of the next bank immediately east;
- (d) The first bank west of St. Rogatien Bank, east of Gardner Pinnacles;
- (e) Raita Bank; and
- (f) Pioneer Bank.

b. The following activities are prohibited within the Reserve:

(1) Discharging or depositing any material or other matter into the Reserve, or discharging or depositing any material or other matter outside the Reserve that subsequently enters the Reserve and injures any resource of the Reserve except for discharges incidental to vessel use such as deck wash, approved marine sanitation device effluent, cooling water, and engine exhaust;

(2) Removal, moving, taking, harvesting, or damaging any living or nonliving Reserve resources;

(3) Any type of touching or taking of living or dead coral; and

(4) Having a vessel anchored on any living or dead coral with an anchor, an anchor chain, or an anchor rope when visibility is such that the seabed can be seen.

c. Protective Measures to Safeguard Corals Located Outside the Reserve. The following measures should be adhered to:

(1) Any amphibious assault or similar training activities shall be limited to marked channels that avoid near-surface corals, where such corals may be impacted by the type of amphibious vehicle contemplated for use.

(2) Inert mines shall not be placed on living coral.

(3) The exceptions to these prohibited activities are as follows:

(a) An emergency poses an unacceptable threat to human health or safety or to the marine environment and admitting of no other feasible solution; or

(b) In any case that constitutes a danger to human life or a real threat to vessels, aircraft, platforms, or other man-made structures at sea, such as extreme weather conditions or similar significant natural events.

12. Sea Turtles and Hawaiian Monk Seals On Beaches. Amphibious landings at MCTAB and PMRF shall adhere to all guidance regarding protection of sea turtles and Hawaiian monk seals on the beach relative to those areas. Mitigation measures shall be instituted to assure minimal impacts to these species. Specifically, prior to conducting a landing exercise, an inspection and survey protocol will include:

a. Within one hour prior to the commencement of an amphibious landing exercise, observer(s) shall survey affected beaches for sea turtles, sea turtle nesting sites, and Hawaiian monk seals. Sea turtle nesting sites shall be marked and no trespassing by persons or vehicles within 50 ft (15 m) of the nest shall be allowed.

b. Should sea turtles or Hawaiian monk seals be found on the beach, the landing shall be

(1) (1) delayed until the animal(s) have voluntarily left the area; or

(2) (2) moved to another location free of such animals.

c. Landing craft and AAV crews shall be made aware of the potential presence of these endangered and threatened species.

13. Inadvertent Discovery of Cultural Resources. Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies to take into account the effects of undertakings on historic properties. Section 110 of the Act requires federal agencies to establish a program of identification, evaluation and protection of historic properties under their control. Military installations in Hawaii have complied with Sections 106 and 110 by consulting on individual undertakings or programs or by executing programmatic agreements on their operations. Installations have also developed integrated cultural resources management plans

1 that identify historic properties and establish standard operating procedures regarding treatment
2 of historic properties and discoveries during a military action. Installation cultural resources
3 specialists or managers are cognizant of who should be consulted for compliance under Section
4 106.

5
6 Discovery Plan: In the event that archaeological resources, historic artifacts, or human remains
7 are discovered during RIMPAC exercises, the following procedures must be followed:

8
9 a. Halt all activities in the area immediately. Protect the resource from further
10 damage and from the weather.

11
12 b. Notify Range Control of the find and any damage caused.

13
14 c. Range Control will contact the appropriate Environmental Office/Department
15 Cultural Resource Specialist or Manager:

16
17 -Puhakuloa Training Area – (808) 969-3340 (from the Island of Hawaii)
18 or (808) 523-5196 (from the Island of Oahu);

19 -Other Army ranges on Oahu – (808) 656-6821 ext 1052;

20 -Marine Corps Base Hawaii Kaneohe Bay and the Marine Corps Training
21 Area Bellows – (808) 257-6920 ext 254;

22 -Navy ranges – (808) 471-1171 ext 233; and

23 -Hickam Air Force Base Hawaii – (808) 449-1584 ext 245.

24
25 d. The notified Cultural Resource Specialist or Manager will implement
26 discovery procedures established under an executed agreement document.

27
28 e. If no agreement document exists for the installation, carry out the following
29 procedures:

30
31 -The installation's Cultural Resource Specialist/Manager will assess the
32 discovery, collect sufficient information to evaluate its significance and National Register
33 eligibility, record the discovery by identifying its location through global positioning system
34 (GPS), photography, and site mapping.

35 -If discovery includes human remains and associated cultural items, follow
36 procedures in accordance with 43 CFR Part 10, implementing regulations of Native American
37 Graves Protection and Repatriation Act.

38 -If discovery is an archaeological resource deemed eligible for the
39 National Register, the installation will determine actions to be taken to resolve the adverse
40 effects and notify the Hawaii State Historic Preservation Officer (SHPO), the Advisory Council
41 on Historic Preservation (ACHP), and Office of Hawaiian Affairs (OHA) within 48 hours of the
42 discovery.

43 -The installation will consider recommendations received from consulted
44 parties and then carry out the appropriate actions.

45 -When the actions are completed, the installation will provide a report to
46 SHPO, ACHP, and OHA.

1
2 14. APPENDICES:
3

4 (1) Summary of Discharge Restrictions

5 (2) Annex P of SOPAPEARL 5000.1F (Environmental Protection Guidance)

6 (3) Marine Mammals/Endangered Species Protection

7 (4) Underwater Explosion Effects Table

8 (5) Environmental Protection Measures Summary Matrix
9